THE SURGICAL TREATMENT OF IRREMOVABLE CANCER OF THE PYLORIC SEGMENT OF THE STOMACH

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ALL recent statistics show that cancer of the stomach is the commonest malignant disease in man, and that in the majority of cases (60 per cent) the pyloric segment is the portion involved.

It is a deplorable fact that although growths situated here often manifest their presence at a comparatively early stage in the disease, giving rise to much gastric disturbance and obstructive symptoms, such a large proportion of them prove to be irremovable when the abdomen is opened. My own figures show that in less than 30 per cent of the cases submitted to operation can any attempt at radical cure be made, and that even when this is feasible the prognosis is less favorable than with cancers situated in the body of the stomach.

Pyloric growths invade the regional lymph nodes rapidly and extensively, and fixation to or penetration of adjacent viscera, such as the pancreas, occurs early in the course of the disease.

In borderline cases it is often exceedingly difficult to ascertain whether growths situated in the pyloric portion of the stomach are resectable or not until full anesthesia has been achieved and until the body of the stomach has been transected and a determined effort made to mobilize the affected segment together with the first part of the duodenum. In those cases in which this has been attempted and in which the growth has proved to be irremovable, the operation should be completed by adopting the method about to be described.

It is proposed to discuss here only the treatment of those cases which have been deemed operable and in which, after exploration, it is found that the growth cannot be resected. In such circumstances the aim of any operation which is undertaken is to prevent the patient from starving to death; to prolong his life, meanwhile rendering him more comfortable as far as his digestion is concerned; to ward off or at least postpone the advent of serious complications such as profuse hemorrhage, perforation, or severe toxemia; and to ensure, as far as possible, that when death does occur it is the outcome of secondary implants in the liver (which produce little pain) rather than of obstruction with its tormenting agonies.

Although hitherto the operation recommended for the type of case under discussion has been posterior or preferably anterior gastrojejunostomy, some operation based on the principle of Devine's,[1] which, in my opinion, best ful-

fills all requirements, is now more generally practiced for the following reasons:

(1) The death rate is no higher than that which follows the simpler short circuiting operation; in fact in my own series of 13 cases treated by this method or some modification of it, there has been no immediate mortality.

(2) The expectancy of life is prolonged. Where gastrojejunostomy has been performed it has been shown that patients usually live for four or five months longer than where simple exploration only is undertaken; but by the procedure here advocated the length of the patient's life may be increased by several months or, in exceptional cases, even years.

(3) The patient is prevented from dying of obstruction, as the gastro-enteric stoma is very large and is widely removed from the primary growth which is excluded. Where, however, a gastrojejunostomy is performed, the stoma is apt to become occluded by the growth which spreads into the body of the stomach from the pyloric region, or to become compressed by metastatic nodes in the mesocolon or great omentum.

In performing a gastrojejunostomy there is also a tendency to place the opening too high up in the body of the stomach in order to ensure that the anastomosis is as far removed as possible from the involved portion of the stomach, often resulting in a poorly functioning stoma which affords but little relief.

(4) The immediate postoperative results are eminently satisfactory; it is at once possible to administer fluid nourishment by mouth in unstinted quantities; appetite is restored; cachexia disappears; and the patient's general health is greatly improved, often so much so, in fact, that in some cases which survive for longer than a year doubt may arise as to the correctness of the diagnosis made at the time of the original exploration.

The following is a brief description of Devine's technic with certain personal modifications which have been introduced in order to render the operation both simpler and quicker.

An injection of omnopon, gr. 2/3, and scopolamine, gr. 1/150, is given about 40 minutes before the operation, which is then, as a rule, performed under local anesthesia.

A midline epigastric incision, extending from the xiphisternum to the umbilicus, is the one generally employed, as it is easy to make and easy to close, and it affords ample and ready access to the stomach.

The stomach is then carefully inspected and palpated, and the exact position of the growth, the amount of stomach involved, and the extent of extra-gastric spread and lymphatic involvement are ascertained.

If, after methodical exploration, a radical gastric resection is considered to be inadvisable, or even impossible owing to the nature of the pyloric growth, but the remaining portion of the stomach is found to be healthy, the body of the stomach should be transected, the pyloric segment excluded, and the operation completed by performing an end-to-side gastrojejunostomy by the antecolic or retrocolic method.

The first step in the operation is the ligature of the main branches of the

right and left gastric arteries, and the freeing of the gastrohepatic omentum from the lesser curvature of the stomach, after which the gastrocolic omentum is widely ligated along the greater curvature so that the body of the stomach may be lifted up and its under surface inspected, any adhesions which may exist here being freed.

The field of operation is carefully packed off with warm Cripps' pads and macintosh sheeting, and a large roll of gauze is introduced into the lesser sac behind the stomach, after which a Friedrich-Petz clamp is applied high up on the body of the stomach from the greater to the lesser curvature, and as far away as possible from the growth in the pyloric segment. The instrument is forced home, the stomach is crushed, and the two rows of clips are inserted with mechanical precision and neatness (Fig. 1).

Fig. 1.—The Friedrich-Petz clamp is applied to the body of the stomach, well away from the growth, and the two rows of metal clips are inserted by forcing the instrument home.

After removing the clamp, two pairs of Allis forceps are applied to the lesser curvature and two pairs to the greater curvature, about one inch away from the crushed portion of stomach. A Sargent retractor is then passed immediately behind the grooved area so that the stomach can be transected between the two rows of clips with a Post electric cautery, the retractor meanwhile affording a firm base upon which to divide the stomach and also protecting the underlying pancreas from injury (Fig. 2).

The pyloric stump is then picked up with Allis forceps, and the crushed end with its single row of clips is invaginated with a continuous Lembert suture of No. 0 20-day chromic catgut, the suture line being further reinforced with a series of closely applied interrupted silk sutures which in turn are buried with a Cushing right-angled stitch of fine silk (Fig. 3).

Thus the pyloric pouch in which the growth is contained and excluded,

when securely closed in this way, presents a smooth, even surface, thereby preventing the subsequent formation of adhesions.

FIG. 2.—Transection of the body of the stomach between the two rows of metal clips, by means of a Post electric cautery. Note the position of the Sargent retractor.
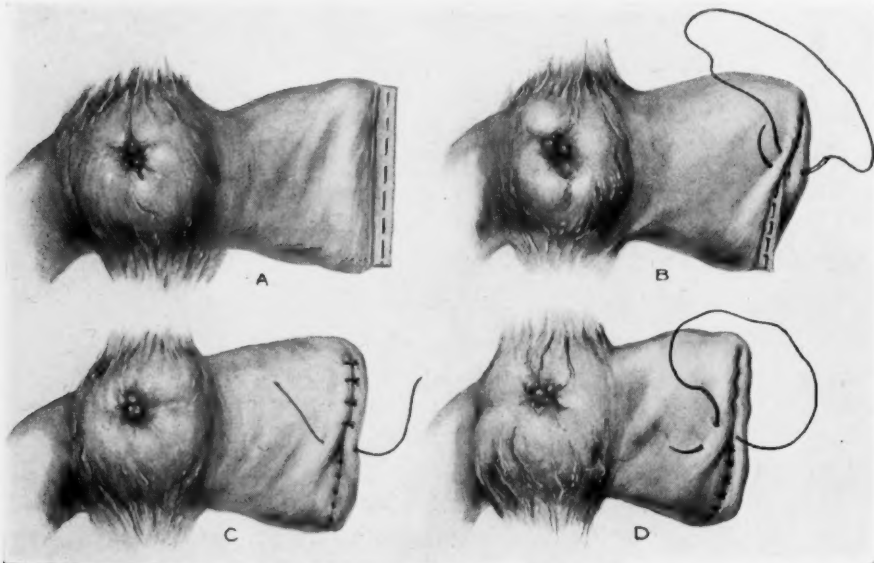

FIG. 3.—Closing the pyloric end of the stomach by means of a series of sutures.

After this step in the operation, the surgeon has to decide whether the anastomosis between the proximal cut end of the stomach and the proximal

FIG. 4.—Exclusion of the growth in the pyloric segment of the stomach, followed by end-to-side anastomosis by the posterior Pólya method.

FIG. 5.—Exclusion of the growth in the pyloric segment of the stomach, followed by the anterior method of anastomosis with entero-anastomosis as recommended by Balfour.

jejunum should be completed by the anterior or by the posterior Pólya method. In the majority of cases the posterior method is both feasible and preferable; but where the mesocolon is very short; where the vascular arches in the mesocolon are numerous or anomalous; where the first few inches of the proximal jejunum are tethered to the mesocolon by developmental or inflammatory bands or adhesions; where enlarged nodes are found to be present in the mesocolon; or where the transection has been performed very high up in the body of the stomach, the anterior method, as practiced by Balfour, has usually proved to be more simple and more satisfactory.

In the posterior operation a fairly large opening is made in the mesocolon, to the left of the middle colic artery, and after identifying the duodenojejunal flexure the first portion of the proximal jejunum is drawn through this opening into the supracolic compartment. The left hand edge of the opening in the mesocolon is sutured to the posterior aspect of the stomach before the anastomosis is commenced, and the right hand edge of the opening is sutured to the anterior aspect of the stomach after the anastomosis is completed.

A portion of the proximal jejunum, some six to eight inches from the flexure, is then applied to the cut end of the stomach from the lesser to the greater curvature, and after trimming away the crushed area of stomach with its contained clips, the anastomosis is performed in the usual manner, without the aid of clamps (Fig. 4).

In the anterior operation the portion of jejunum selected for the anastomosis with the stomach should be some 12 inches or so from the duodenojejunal flexure, and this is applied from the lesser to the greater curvature. When the row of clips which closes the stomach has been trimmed away, the anastomosis between the cut end of the stomach and the jejunum is performed, as in the operation of gastrojejunostomy.

At the completion of this operation a small entero-anastomosis is made between the afferent and efferent limbs of the jejunum, usually at a point about two inches above the duodenojejunal flexure (Fig. 5).

The abdominal wound is then closed with two rows of continuous sutures of No. 1 chromic catgut, and further reinforced with supporting sutures of silkworm gut to guard against the possibility of wound dehiscence, the skin edges being approximated with interrupted sutures of fine silk.

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MYCOTIC INFECTION OF THE STOMACH

REPORT OF A CASE WITH PERFORATION

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MYCOTIC infections of the stomach are so infrequent and their pathogenicity so little understood that additional information on the subject is desirable. We wish to present a case of gastric fistula due to a mycotic infection of the stomach, a complication that does not seem to have been reported previously.

While the consensus of opinion is that fungi can cause an infection of the gastric mucosa, such as gastritis,[33] and can go on to ulceration,[1a, 13, 20, 23, 36] yet there are some investigators[28, 2, 34, 17] who attach little or no importance to the presence of fungi in the stomach. In evaluating the significance of fungi in any case, one must be certain that the organisms were permanently growing in the stomach and were not carried there as contaminants of food or of the gastric tube when it passed through the pharynx. Fungi are frequently found in the mouth probably because of their widespread distribution in food and air; according to Merke[24] and Brunstein[7] molds are found in 40 per cent of the buccal cavities of normal people. There are no reports, however, showing the incidence of fungi in both the stomachs and buccal cavities of the same patients. Because of the swallowing of saliva and food, it would seem logical that fungi would be found in the stomachs of the patients who have molds in the mouth.

Cafasso,[9] Hartwich,[12] Moppert and Kagan[26] examined stomach aspirations and found fungi in 40 to 60 per cent of their cases. Crasset found molds in 20 of 30 stomachs examined at autopsy. Cushing and Livingood[11] found that the duodenal contents during the interdigestive period were sterile; Ricen[31] and Henning,[15] however, found a low incidence of molds in duodenal ulcers.

In early mycotic gastritis, a thick membrane of fungi is found lying on a seemingly intact mucosa. Because of trauma or local vascular damage such as ischemia or hemorrhage, the organisms may cause a superficial ulceration in the underlying tissue.[1b, 4, 12, 21, 27] They may penetrate to the muscular layer[5] or serosa.[22] The ulcerations may be either single or multiple, and they may vary in size from 1 Mm. to a lesion involving the whole stomach. The distinctive feature of these ulcers, as seen at operation, is the presence of a necrotic discolored membrane over the base and the sometimes brown-

ish granular appearance of the ulcer edges. Whenever fungi are found on microscopic examination in ulcers of this description, their presence is most significant.[4, 9, 12, 13, 14, 24, 37]

Fungi in ulcers appear as scattered branching threads with globoid swellings devoid of fructification forms, lying in the superficial necrotic layer and contiguous intracellular spaces. Castellani and Chalmers[10] have shown that fungi often lose their characteristic morphology when growing parasitically in the tissues; therefore, many mycelial threads may be seen with but few oval, yeast-like bodies. This change has also been observed by Singer[33] and Von Meyenburg,[37] who, like ourselves, obtained abundant typical growths of fungi when tissues were transplanted to acid media favorable to the growth of fungi and in which they grow best, but their abundance in achlorhydria is probably due to symbiotic growth with the many other organisms commonly found in gastric juice devoid of hydrochloric acid.

Nye, et al.,[29] examined stools of patients in their series and found fungi in 42 per cent. The cultures, however, were not considered positive unless there were 10 or more colonies of fungi per plate, thus reducing the incidence to 15 per cent. Most of these were Parasaccharomyces ashfordi. The incidence did not seem to be influenced by the gastric acidity.

Actinomycotic infections of the stomach are rare.[32, 41, 18] The only distinctive feature is the presence of ray fungi in the wound scrapings. Blain[6] reports a death from actinomycosis three months after a subtotal gastrectomy for a seemingly grossly malignant ulcer of the lesser curvature of the stomach. No fistula developed at any time. When the autopsy showed many actinomycotic hepatic abscesses, the stomach was sectioned again. Out of 330 slides, 12 were found to have ray fungi scattered in the periphery of the ulcer.

Classification of fungi is still so complex that identification of organisms isolated from ulcers is often difficult. Nye, et al.,[29] and Meyer[25] believe that the various generic names represent the same organism: i.e., Oidium, Monilia, Saccharomyces, Endomyces, Parasaccharomyces, and Blastomyces. Meyer[25] says that the various bizarre forms cultured by the many authors are probably the same organism which has been modified by the hydrogen ion concentration of the culture and by the type of media used. The majority of cases where fungi were mentioned were due to Monilia, and a few were due to Aspergillus. These two organisms were predominant, but there were also scattered colonies of Streptothrix and sarcinae.

The symptoms of mycotic infections of the stomach are so like those of other acute infections[25] that preoperative diagnosis has never been made. Vomiting of blood is an almost constant characteristic of a fungous infection, and, of course, the finding of strands of molds in the vomitus or in the aspirated gastric contents is suggestive of the diagnosis. Even operative findings are so insignificant that diagnosis is difficult. The distribution of the possible sites of the ulcer is the same as that for round gastric ulcer.

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Examination of biopsy, as in the case we will report, may be the first clue to the diagnosis.

The prognosis in mycotic infections cannot be determined inasmuch as a preoperative diagnosis has never been made. In mycotic ulcers recognized after operation, no untoward effects developed which might be attributed to fungi. Should a rare actinomycotic ulcer be found in the stomach, the prognosis is deferred since microscopic metastasis to the liver may have occurred.

CASE REPORT

M. M., Negress, 24 years of age, a native of Nova Scotia until 1933, was admitted to the Beth Israel Hospital May 6, 1934.

Past History.—Ten months previously, the patient was treated at the Boston Dispensary for chronic lymphatic leukemia of three years' duration.

Present Illness.—Increasing weakness, loss of 37 pounds, vertigo and anorexia. For six weeks, she has had epigastric distress after eating which was sometimes accompanied by nausea and vomiting; the vomitus consisted of blood-streaked food. Dyspnea with palpitation on exertion and a slightly productive cough. There was edema of the ankles. No melena was present. Amenorrhea for five months which was preceded by marked menorrhagia for one and one-half years. On one occasion, there was painless hematuria.

Physical Examination.—Temperature, 101° F. Mucous membranes, pale. Chest, negative. The heart had a short puffing diastolic pulmonic murmur. The only peripheral lymph nodes felt were a few in the right groin and a non-tender, firm node measuring 2 cm. in the right axilla. The abdomen was slightly rounded without tenderness or spasm. The liver edge was sharp and displaced downward to the level of the umbilicus. The spleen extended below the crest of the ilium. The erythrocyte count was 2,300,000; hemoglobin, 45 per cent. Leukocyte count, 14,250; 84 per cent lymphocytes, 14 per cent polymorphonuclear neutrophils and 2 per cent large monocytes. There were no abnormal cells. Platelets, 399,600 per cmm. Icteric index, 11.25. Hinton, Kahn, and Wassermann reactions, negative. The basal metabolic rate varied from + 18 to + 13. Sedimentation index, 0.18.

Clinical Progress.—Two days after admission, the patient developed a throbbing ache in the right upper quadrant of the abdomen which reached its maximum in 24 hours. Examination revealed an unaltered liver dulness with marked tenderness and spasm in the medial half of the right hypochondrium. During the next three days, the pain was localized over a well defined, rounded mass under the right costal margin, measuring three inches in diameter, which was firm and very tender. The rest of the abdomen was slightly distended but otherwise negative. During the next two weeks, the temperature varied around 104° F. A laparotomy was then performed with a preoperative diagnosis of an intra-abdominal abscess, the etiology of which was obscure.

Operation.—A four inch paramedian incision was made over the slightly elevated mass in the right upper quadrant of the abdomen. Considerable edema of the muscle and preperitoneal tissue was encountered. Immediately after the parietal peritoneum was opened, a large cavity was entered lined by a thick wall of brownish necrotic tissue without any frank purulent manifestations. The walls were formed by the gallbladder and the right lobe of the liver above, and by inflammatory tissue which was difficult of recognition for the rest of its circumference. Cultures were taken; a small amount of necrotic tissue was removed for examination. A cigarette drain was placed down to the center of the inflammatory area without any further investigation of its depths.

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For 48 hours after the operation, there was a slight seropurulent drainage. After the drains were removed on the second postoperative day, a large amount of watery fluid resembling gastric juice welled up in the wound. Food was seen to exude shortly after ingestion. During the postoperative course, the patient had a sustained temperature of 104° to 106° F. She developed pulmonary congestion and died 14 days after operation. During this period the erythrocyte count was 2,550,000, hemoglobin was 55 per cent; the leukocyte count gradually dropped to 7,000 with 55 per cent lymphocytes and 45 per cent polymorphonuclear cells. The van den Bergh rose gradually to 3.04 mg.

Cultures of peritoneum taken at the time of operation showed a moderate growth of Staphylococcus albus. Pathologic examination of the tissue removed at operation from the abscess wall showed that it consisted chiefly of necrotic connective tissue, in which could be seen many colonies of innumerable gram-positive filaments having spheres and club-shaped bodies at their ends. In places, the entire abscess wall appeared to be
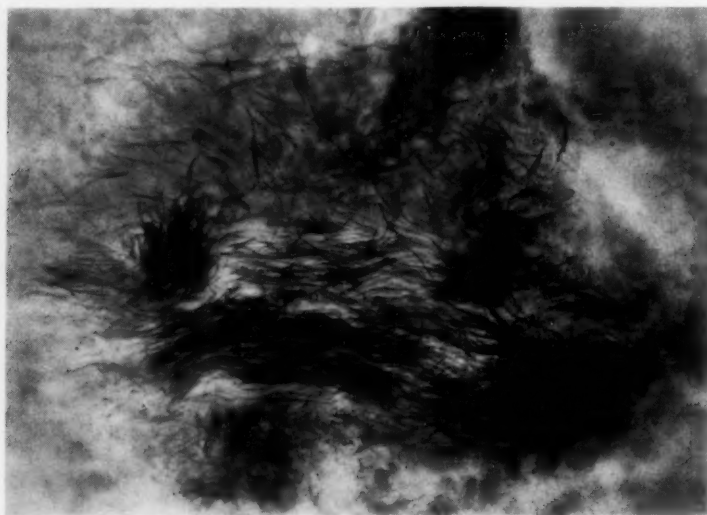

FIG. 1.—Section through the wall of the gastric fistula showing mycotic filaments and occasional ovoid bodies ($\times$ 325).

made up of a network of these gram-positive filaments of fungi (Fig. 1). External to the abscess wall, there was a large amount of fibrin enmeshing innumerable lymphocytes, monocytes, polymorphonuclear leukocytes and occasional eosinophils.

On the fourth postoperative day, a punch biopsy was taken from the depths of the wound. Dr. Leo Rane reported that the biopsy gave a heavy growth of Monilia albicans. Repeated analyses of the abundant fluid in the fistulous tract revealed no free acid; the total acidity averaged 33 units. Lipase and rennin enzyme tests were positive, and trypsin and amylase tests were negative.

Autopsy Report.—The autopsy was performed three hours after death. The pertinent findings were reported by Dr. Monroe Schlesinger and Dr. Stanley Frehling. There was marked pitting edema from the toes to the vulva. Several discreet nodes, some of which measured 3 cm. in diameter, were found in the right axilla. There was a gaping high right rectus incision which communicated with the greater curvature of the stomach through a fistulous tract; the skin around the incision was slightly reddened with no digestion of the edges. The walls of the fistula were composed of the hepatic flexure of the colon, the inferior surface of the liver, the gallbladder, the first portion of the duodenum, and a greatly indurated hepatocolic omentum. The fistula was well localized by the indurated fibrotic tissue which filled the interstices between the above

mentioned organs. The rest of the peritoneum was normal. The fistula which was 6 cm. in diameter opened into the stomach at the greater curvature about 2.5 cm. above the pyloric ring, and extended in saddle-bag fashion along the posterior and anterior surfaces. There was marked edema of the mucosa surrounding the opening, with undermining of the edges. Distally, the mucosa was yellowish-brown and quite edematous so that the usual folds were obliterated. Elsewhere, the rugae were not unusual except for numerous petechial hemorrhages.

The superior wall of the hepatic flexure of the colon was involved in the induration for a length of 5 cm. At the middle of the indurated area the overlying mucosa had an irregular ulceration 1 cm. in diameter. The ulcer edges were slightly thickened and the base was formed by a septum of fibrous tissue 2 Mm. in thickness which completely replaced the muscle wall. No evidence of communication was found between the fistula and lumen of the colon.

The liver weighed 2,160 Gm., having a uniform light yellowish-brown color. The surface was smooth except on the inferior surface where there was a ragged grayish-green area measuring 10 by 3 cm., marking its apposition to the fistula. The spleen weighed 1,020 Gm. and had an area of perisplenitis 7 cm. in diameter at the upper pole. The mesenteric lymph nodes were enlarged to 2.5 cm. and were discreet. Similar enlarged nodes were found in the mediastinum. Both lungs showed marked atelectasis with numerous small petechial hemorrhages. The bone marrow obtained from the femur and from the ribs had a serosanguineous appearance.

Microscopic sections of the stomach were essentially normal except for an area about 3 cm. in width which surrounded the fistulous opening. Here the submucosa and serosa were thickened and fibrosed; the mucosa showed marked edema and the muscularis was practically unchanged. The superficial tissue of the sinus tract was necrotic and had a slight leukocytic infiltration. There were numerous bacteria, chiefly long, tortuous forms with occasional branching. The underlying zone was less necrotic although it contained many of the same filaments which were shorter than those found in the superficial tissue. Several small vessels filled with a fibrin thrombosis were present at the border of the necrotic zone. There was a remarkably small amount of inflammatory reaction in the adjacent tissue considering the marked degree of necrosis.

Sections through the hepatic flexure of the colon showed that the mucosa ended abruptly at the ulcer. The mucosa and submucosa were thickened and were infiltrated with closely placed, small round cells, fibroblasts, and scattered eosinophils. The floor of the ulcer was almost entirely composed of a thick layer of dense fibrous tissue which had replaced the wall of the colon at this point, and was blended with the pericolic induration.

Sections of the spleen showed a diffuse fibrosis of both the pulp and capsule. The corpuscles were poorly defined. There was no unusual cellular infiltration, and there was a scarcity of lymphocytes throughout.

Sections through the liver were essentially normal except for the area marking the fistula. This area showed a necrotic superficial layer composed entirely of disintegrated eosinophilic cells intermingled with a large number of rod-shaped organisms. Under this, there was a thin zone of fibrinous infiltration covering a strata of liver in which there was central degeneration varying from fatty infiltration to definite necrosis. Here also were seen a moderate number of rod-shaped organisms. The periphery of the inflammatory area, which was 2 cm. from the fistula, showed a moderate degree of portal fibrosis and lymphocytic infiltration.

Many lymph nodes showed a marked fibrosis which obscured the stroma. This appeared as a tremendous thickening of the septae of the nodes. The intervening sinusoids were almost empty, containing only a sprinkling of normal appearing lymphocytes and a few reticulum cells. Other nodes were not fibrosed; they also had a loose empty structure with very few cells.

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of a pyogenic abscess, leads us to conclude that the patient had a mycotic ulceration of the stomach which perforated with a resulting fistula.

SUMMARY AND CONCLUSIONS

(1) This is a case report of a patient who had an abdominal abscess with a gastric fistula.

(2) The presence of many fungi in the abscess and the fistula, the absence of histologic evidence of a pyogenic etiology, and our inability to demonstrate any other etiology warrants the conclusion that the ulceration was due to the fungi.

(3) That fungi may cause gastric ulcerations has already been noted but that the process may go on to fistula formation has not been reported previously.

(4) The almost complete absence of microscopic evidence of leukemia at autopsy when clinical evidence warranted such a diagnosis cannot be explained. It was probably due to a state of organic remission of the chronic lymphatic leukemia. Whether or not the terminal fever played a part in the remission is questionable.

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PATHOLOGIC CHANGES IN EXTERIORIZED
GASTRO-INTESTINAL GRAFTS

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PART I.—EXTERIORIZED BOWEL.—In the course of certain experiments dealing with the physiology of exteriorized bowel[1] the question of pathologic change has been raised with sufficient frequency to merit its detailed description. This paper will attempt to describe the changes taking place in the morphology of various portions of the tract under this and other atypical conditions.

The conditions under which the first group of experiments were performed, that is, with exteriorized bowel, will be considered first. The method of preparation is as follows:

A segment of the gastro-intestinal tract (stomach, small intestine or colon) is isolated and a portion supplied by a single vascular arch resected, leaving the mesenteric pedicle with its blood and nerve supply intact. The resultant ends of bowel are anastomosed end-to-end and returned to the abdominal cavity. In the case of the stomach, a section is removed from the greater curvature leaving a branch of the lienal vessel attached, after which the gastric defect is closed. The abdominal incision is closed in layers about the mesenteric pedicle up to the skin. A section of skin corresponding roughly in size to the expected bowel graft is removed. Next the bowel is opened along the antimesenteric border, spread open, and the surface thoroughly cleansed by saline and alcohol. Finally, the bowel is sutured in place forming a flat graft with the mucosal surface outward. After a period of 10 to 12 days the graft is healed (Fig. 1), usually without infection, and ready for subsequent experimentation upon the motility of the intestinal musculature.

Little change may be noted in the surface of the graft for several months. There is perhaps a little more edema and hyperemia than normal. After periods of from four to ten months, depending upon the portion of the tract utilized, certain changes will be definitely established. For the purpose of clarity these will be described separately as early and late changes in the various portions of the graft.

Mucosa.—There is little change in the mucosa in the early stage. It continues to secrete a great deal of mucoid material, similar apparently to the normal secretions. The surface is hyperemic and darker in color than normal. During this period histologic examination demonstrates a beginning destruction of the tips of the villi, a "wearing off," so to speak, whereby they are denuded of muscosal cells (Fig. 2). A mild degree of cellular infiltra-

tion may be noted, but this depends almost entirely upon the amount of surface destruction. These changes, it should be noted, occur earlier in the colon than in other portions of the tract. The junction of the skin and mucous membrane presents a fused unbroken line with no appreciable change in the cells of either (Fig. 3). It is a well defined line with a small amount of granulation tissue and fibrosis.

In the later stages the mucosa takes on a grossly granular appearance (Fig. 4). It bleeds easily to slight trauma and appears to be covered by exudate. This likewise appears first in the colon and stomach preparations, later, if at all, in the small intestinal grafts. The phenomenon appears to be
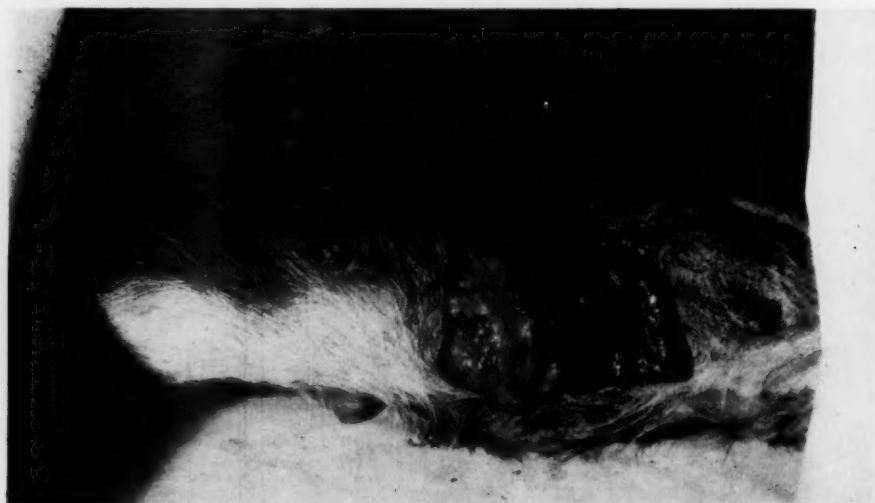
FIG. 1.—Photograph of a graft from the colon to the abdominal wall three months after operation. Note the traumatized area at one end from application of recording clips. The surface is shiny from secreted mucus.

due in part at least to mechanical irritation by scratching, contact with abrasive surfaces and to drying. Microscopically the mucosa exhibits partial destruction which varies greatly in degree. The milder changes usually seen in the small intestine show surface destruction with exudation which tends to close the openings of the crypts. This produces obstruction of the crypt with cystic dilatation at the base by the products of secretion (Fig. 2). In other more advanced preparations the mucosa may be almost entirely gone and only remnants of epithelium in a mere semblance of the original acinar arrangement remain upon a base of inflammatory granulation tissue (Fig. 5). It is of greatest importance to note the evidence of regeneration in mucosal epithelium especially at the bases of glands. During the process of disintegration one not infrequently sees epithelial budding from the side of a gland (Fig. 6). These budding cells project into the lumen from one side in a manner suggesting small papillomata. They stain more darkly with hematoxylin-eosin than the adjacent cells, and with muci-carmine there is evidence of greater mucoid secretion. Another manifestation of regenera-

tion is seen in areas devoid of epithelium through the agency of severe trauma such as being bitten or chewed. Healing in such an area takes place primarily by granulation tissue which tends to be covered by a thin layer of epithelial cells without, however, the normal acinar arrangement (Fig. 7).

FIG. 2.—High power photomicrograph of an ileal graft five months after operation. Note the superficial destruction and deposition of fibrin. The bases of some of the crypts are dilated by distension with secretory products. The muscularis mucosa is edematous and partly disrupted and moderate cellular infiltration can be seen in the superficial layers.
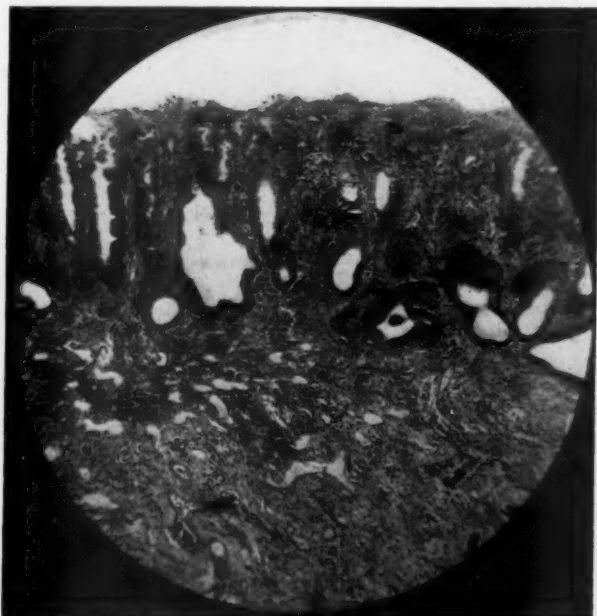
FIG. 3.—Junction of skin and mucous membrane. The epithelial cells of both structures are fused and a few glandular elements can be seen migrating beneath the skin edge.
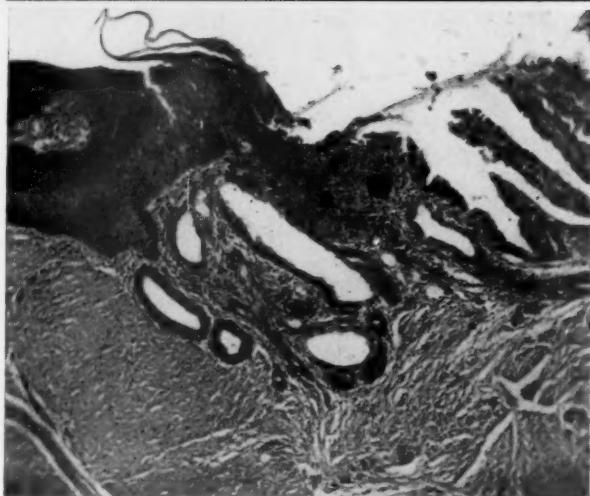
Cellular infiltration is more marked in older preparations and again is dependent upon the amount of surface destruction. The cells taking part in this infiltration are chiefly leukocytes. There are also numerous small lymphocytes and wandering cells, some of which demonstrate phagocytic activity.

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Another interesting change in the late stages is the frequent extension of squamous epithelium from the skin margin out over the muscosal surface. This appears to take place more readily in a previously traumatized area in which the destruction of epithelium has been partly succeeded by the deposition of a layer of fibrinous exudate. Curiously enough, these epithelial extensions seem to start out first as tiny promontories, but later the tips expand rapidly in all directions so that the final result shows an island of squamous epithelium connected to the natural skin margin only by a narrow pedicle. How far this extension would progress if allowed to go untouched it is impossible to say, since no case has been observed in which a muscosal graft
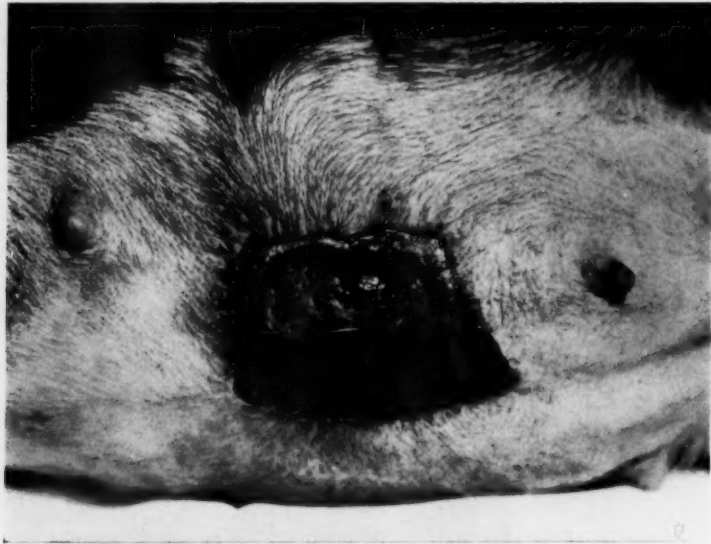
FIG. 4.—Colon graft ten months after operation (same preparation as in Fig. 1). Note the smooth surface with absence of mucosal wrinkles and the granular appearance in places, although mucus is still being secreted.

has been entirely replaced. It seems safe to say, however, that as long as there is actively secreting mucosa present, it will not be covered.

Muscularis Mucosa.—This structure shows no early changes. As the superficial destruction progresses, one notes first a thickening which might indicate a hypertrophy were it not for the splitting apart of some of the fibers by edema which in later stages results in a disruption of continuity almost to the point of total destruction (Fig. 8). This phenomenon may in part answer the question as to the rôle played by this structure in intestinal motility. In spite of the actual destruction of the muscularis mucosa, the intestinal graft *retains its ability to contract following the application of superficial stimuli.*

Cellular invasion attacks this layer in the same manner and type as the mucosa, but only after the latter structure has been partially destroyed.

Submucosa.—The submucosa likewise undergoes an edematous thickening in the early stages which later results in an increased fibrosis. Vascularity

is markedly increased and the vessel walls become thickened. Not infrequently epithelial cells from the mucosa migrate downward through the disrupted muscularis mucosa and form islands in the submucosa which display a characteristic tendency to reform acini (Fig. 8). Such inclusions have

FIG. 5.—High power photomicrograph ten months after operation (same preparation as Fig. 4). There is almost complete absence of mucosal epithelium except for isolated remnants. In the right of the field can be seen a hypertrophied lymph follicle. The submucosa is edematous and the muscularis mucosa is partially disintegrated. This preparation retained an active muscular response to surface stimulation.
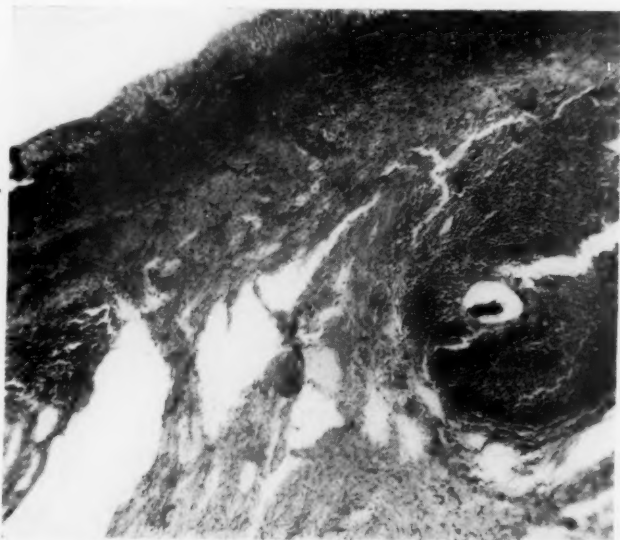
FIG. 6.—Budding within a mucosal gland. In the upper part of the field this has progressed to a true papilloma. In the lower part can be seen the early budding from both sides of a crypt.
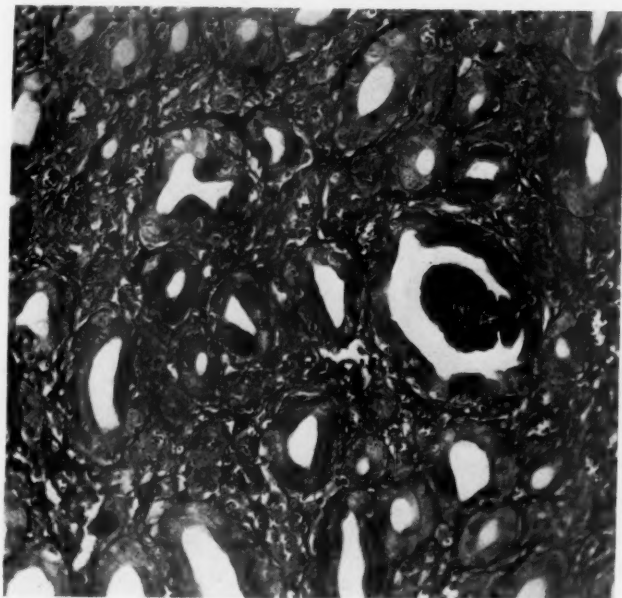
been noted in the subcutaneous tissue beneath the skin edge as far as one centimeter from the nearest mucosal border. In the late stages through the process of cellular invasion and advanced fibrosis, the submucosa presents
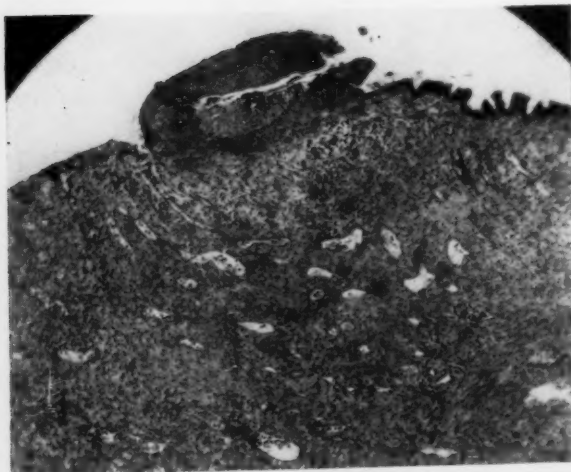
FIG. 7.—Epithelium grow-
ing out over granulation tissue
in a defect left from severe
trauma. There is a tendency
to reproduce acini but as yet
they are incompletely formed.
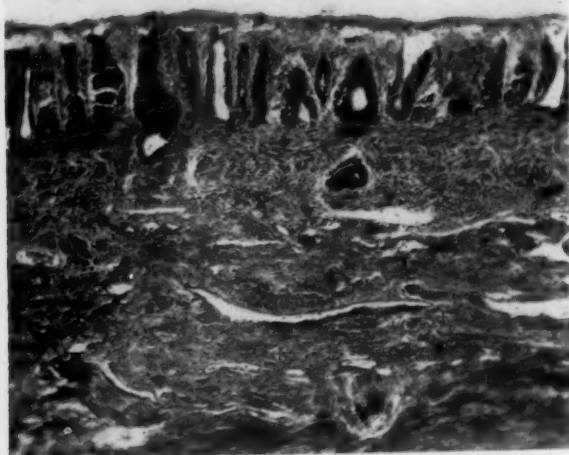
FIG. 8.—Penetration of the
muscularis mucosa by the deeper
part of the mucosal glands. On
the right an island of mucosa
has completely penetrated it while
at the left can be seen an earlier
stage of penetration.
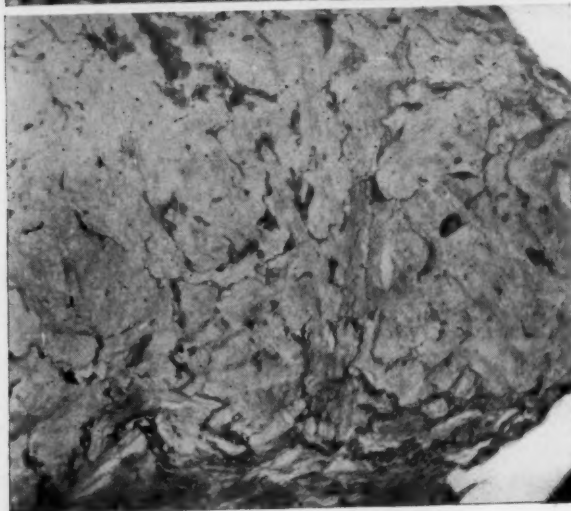
FIG. 9.—Colloid-like accu-
mulation of mucus encapsulated
by omentum about an intraper-
itonealized section of colon. It
is surrounded by a single layer
of endothelium. This material
stains bright red with muci-
carmine.

a picture not unlike the base of a chronic ulcer without, however, the destruction of the underlying muscle (Fig. 5).

Muscularis.—This layer exhibits the least changes of all. There is, as a rule, thickening and hypertrophy. Rarely, if ever, is there disintegration or destruction of the muscle bundles although in the late stages moderate cellular invasion may appear. Hypertrophy of the sympathetic ganglia of the plexuses of Meissner and Auerbach has been noted in some instances, but it cannot be said that this is a constant finding.

Section of the mesenteric pedicle apparently does not alter the type of change brought about. A slight dryness of the mucosal surface for a few days after section has been the only difference thus far noted. The development of collateral circulation is usually rapid and sufficient to furnish nourishment to the more delicate intrinsic structures. Possibly this is a factor responsible in part for the questionable ganglion hypertrophy. Certainly it can be said that pedicle section does not destroy the intricate neural mechanism.

PART II.—PERITONEALIZED MUCOSA.—The second group of experiments was designed to demonstrate the effects of peritoneal exposure upon the mucosa. The following procedure was carried out: A transverse V-shaped flap was cut in the antimesenteric portion of the colon of a cat, retracted and tacked down so that the mucosa faced outward. The mucosa was then divided across the base of the triangular flap and the colon defect closed. The preparation was then cleansed thoroughly with saline and alcohol and dropped back into the abdominal cavity. The incision was finally closed in the usual manner.

None of the animals so treated showed any sign of peritoneal irritation following the procedure but after two or three days the abdomens exhibited gradual and apparently painless distension. This was maintained for several days but slowly decreased to normal. Exploratory laparotomy performed during the distended stage revealed quantities of mucus lying free in the peritoneal cavity but no evidence of visceral or parietal inflammation. A later operation after the distension had disappeared showed still active secretion which was apparently being absorbed. Invariably fibrin had collected about the triangular flap and as a rule, omentum was adherent. Biopsy of the mucosal flap three months after the original procedure showed no demonstrable change in the histology of the mucosal cells.

The experiment was then carried out on dogs in a slightly different manner. A section of colon supplied by a single vascular arch was resected, leaving the mesenteric pedicle intact and the continuity of the bowel reestablished by end-to-end anastomosis. The resected loop was next opened along the antimesenteric margin and cleaned in the manner previously described. It was everted and the cut margins sewn together around and through the mesentery. The preparation thus formed composed a hollow structure resembling the normal bowel except that the serosa formed the inner lining and the mucosa the outer covering. Finally, the preparation

was dropped back into the abdominal cavity and the incision closed in the usual manner. The same procedure was carried out on different animals using the ileum instead.

Following operation there was no sign of peritoneal irritation at any time but in contrast to the previous group of experiments there was no appreciable distension of the abdomen with mucus. At regular intervals the abdomen was opened, the preparation studied, and a biopsy taken. The results were as follows:

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Twenty-four Days.—The abdominal cavity contained little mucus. The omentum was adherent to the preparation, especially at the lines of suture, but the surface of the mucosa was bright, shiny, and actively secreting. Microscopic study showed no cellular changes whatever. The ileum presented similar findings.

Forty-nine Days.—No free mucus was found in the abdominal cavity but small collections were encapsulated along the mesentery and the omental folds. Microscopic examination showed no structural change in the intestinal wall and healing was complete at the united margins, the muscle being united by fibrous tissue.

Seventy-three Days.—Changes were essentially those noted in the 49 day specimen.

Two Hundred Days.—The pathology was essentially the same as in the previous specimens except for an excess of encapsulated mucus. This had distended the serosa of the omentum and the omental folds until it resembled a cluster of grapes. Histologically, this was not unlike the accumulations found in colloid cancer (Fig. 9). The mucosa continued to secrete actively and no change could be noted in the morphology of the epithelium. The ileal preparation was similar except for the preponderance of mucus in the former.

DISCUSSION.—While perhaps of more academic than practical interest, these experiments have shown that the intestinal mucous membrane is a relatively hardy structure which can not only survive but actually regenerate under unusual and adverse conditions. Mechanical irritation appears to play the major rôle in the changes produced. Infection is warded off by the excellent protection afforded by the secreting mucosa, and rarely if ever does inflammatory change involve the underlying structures until this layer is broken. Such a point may possibly have some bearing upon the relationship between chronic gastritis and peptic ulcer.

The mucosal epithelium exhibits amazing regenerative powers following trauma. This is made possible by the ability of the cells to continue reproduction in spite of the altered environment and the loss of the original nerve and blood supply. Penetration of the muscularis mucosa by epithelial cells clearly demonstrates that this phenomenon does not necessarily indicate malignancy.

The persistence of intestinal muscular activity after partial or complete destruction of the muscularis mucosa proves that this structure is not the chief factor in the production of peristaltic movement as has been supposed by some investigators. The slight diminution of muscular response often noted in old preparations can be easily explained on the basis of diminished stimulus receptivity.

As for the practical application of these experiments, mention has already been made of the studies in intestinal motility made possible, thereby opening up a new field in the study of intestinal physiology. Moreover, in keeping with the recent advances in the transplantation of tissues, it has been shown the intestinal mucosa can be successfully transplanted to other portions of the body. Such a procedure can possibly be employed in the replacement of mucosa elsewhere in the body which has been destroyed through the agency of trauma or malignant growth.

CONCLUSIONS

Transplantation of gastro-intestinal segments to the abdominal wall has shown that the structure can remain viable and actively motile for indefinite periods of time, despite the severance of the natural nerve and blood supply, if a sufficient length of time has elapsed to allow collateral circulation to develop.

The pathologic changes involving the transplanted tissues are respectively, gradual destruction of the mucosa with cellular infiltration but a persistent secretory capacity and a characteristic regenerative power; partial destruction of the muscularis mucosa with penetration by migrating epithelial buds; edema and fibrosis of the submucosa with hypertrophy and hyperplasia of the smaller arterioles; and finally questionable hypertrophy of the lymphoid follicles and sympathetic ganglia.

Exposure of the mucosa to the peritoneum produces no apparent histologic change in the former, nor is the secretory activity inhibited. Accumulated mucus is enveloped by fibrin and omentum producing a structure not unlike the jelly-like collections of mucus in colloid cancer.

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SOLID TUMORS OF THE MESENTERY

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Solid tumors of the mesentery are noted infrequently. A comprehensive review of the literature discloses 186 reported cases. Cystic tumors of the mesentery are more common, the ratio being about two to one. The rarity of the condition prompts the following case report together with a brief summary of all recorded cases for the past 15 years.

CASE REPORT

J. M., a male, 46 years of age, a native of Poland, was admitted to the Alexian Brothers Hospital March 27, 1931, for an abdominal operation. He had been a resident of Chicago for the previous 23 years. A large swelling was discovered accidentally in the lower part of his abdomen. It was with difficulty that he was convinced that there was anything unusual about his abdomen since he firmly maintained that he had been unaware of the presence of the swelling and that he had never been ill a day in so far as he could remember. There had been no recent gain nor loss in weight; digestive and urinary disturbances, bleeding from the bowels, and acute abdominal attacks were denied. There was no history of injuries or previous operations. The family history was negative.

Physical Examination.—Temperature, 98° F.; pulse, 72; respiration, 18; blood pressure, 138/82. He was 66½ inches tall and weighed 138 pounds. The build was stocky; he had a ruddy complexion and was well nourished. There were no palpable lymph nodes. The abdomen presented a uniform enlargement in its lower two-thirds about equaling that produced by a seven months pregnant uterus. The outlines of this mass were readily determined. It was not sensitive; the overlying wall was tense and thinned. It was situated for the greater part in the lower half of the abdomen with one-third of its volume to the left of the midline and with the remainder to the right. The lower limit was just above the symphysis while the upper limit lay two fingerbreadths above the umbilicus. Over the lower pole a firm nodule was palpated which appeared to be attached to the larger mass. The entire mass could be slightly moved from side to side. It could not, however, be moved in an upward and downward direction. The impression was given to the palpating hands that it was more or less firmly fixed. It did not move with respiration. Percussion over the tumor elicited a dull note. There was no shifting dulness in either flank. The liver and spleen were not palpable.

Red blood cells, 3,970,000; hemoglobin, 75 per cent; white blood cells, 6,500; differential count: polymorphonuclears, 69; small lymphocytes, 29; eosinophiles, 1; transitionals, 1. The Wassermann and Kahn tests were negative, a plain roentgenogram of the chest was negative. Another made of the abdomen showed the outline of the lower poles of the kidneys to be normal in size and in position. Gastro-intestinal series (barium meal): there was no delay in the emptying time of the stomach or of the small intestine. No deformities were seen. A large shadow persisted on all the films of the abdomen with the ascending colon to the right and the transverse colon above. The transverse colon appeared to be resting on top of the mass and did not present its normal downward convexity (Fig. 1). The small intestine was crowded upward and to the left. The preoperative diagnosis was mesenteric tumor.

Operation.—March 31, 1931. Ethylene and ether anesthesia. The abdomen was opened

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through a right paramedian incision. A large bluish-gray tumor presented which practically filled the abdomen. (Fig. 2.) No free fluid was present. There were no masses in the omentum and no nodules could be palpated in the liver. No enlarged lymph nodes could be palpated in the root of the mesentery. The liver and spleen were not enlarged. There were remarkably few adhesions between the mass and the surrounding structures. Passing across the mass upward and to the left was a loop of ileum about 18 inches in length, the mesentery of which was a part of that in which the tumor was located. The blood supply of this loop passed directly through the mass and was incorporated in it. Equal parts of the tumor lay to either side of this segment of mesentery so that it was impossible to separate the two without destroying the blood vessels supplying this part of the small intestine. The involved segment of bowel was in the lower ileum. The tumor had partly undergone cystic degeneration. It was impossible to deliver it from the abdomen because it was firmly held in the root of the mesentery. Four hundred fifty cc. of serosanguineous fluid were aspirated from the mass. The opening made by the trocar was immediately closed, and the partly collapsed structure was drawn into

FIG. 1.—Showing the transverse colon above and apparently being supported by the mass below.

FIG. 2.—The growth removed with the mesentery and attached segment of ileum.

the abdominal incision. Two points six inches above and below the involved ileum were selected and a lateral anastomosis was made. The intestine was divided and the detached segment of ileum together with the adjacent mesentery and the tumor were then removed in one mass. Recovery was uneventful and the patient was discharged from the hospital April 20.

Pathologic Report.—Macroscopic—A bluish-gray tumor intimately associated with the mesentery with an attached segment of small intestine 25 inches in length. The tumor was 21 inches in its greatest circumference and weighed 5½ lbs. On its lower pole were three nodules. The largest of these was the size of a goose egg. It was cystic with firm thick walls. The other two were solid. The center of the principal mass was necrotic and contained a bloody fluid with a thick deposit of broken down tissue. The inner surfaces of the cavity were irregular and friable. The wall varied in thickness from 1 to 4½ cm. The cut surface was of varying consistency. There were soft areas not greatly differing in appearance from that of the white matter of the brain, while others were firm and leathery.

Microscopic (Dr. R. H. Jaffé)—The wall of the cystic cavity shows three different layers. The outer layer is composed of dense fibrillar connective tissue with small perivascular round cell infiltration. The middle layer which is sharply separated from the

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outer layer is made up of polymorphous cells in a vascular tissue. Large spindle cells with oval nuclei containing numerous small chromatin granules are predominating. They are arranged in different directions and are separated by a small amount of collagenous ground substance. Between these cells are single very large elements with huge irregular nuclei. They are the transition stages between the huge cells and the smaller spindle cells. Scattered loosely between the cells previously described are found small round cells and a few eosinophilic leukocytes. Mitotic figures are quite numerous and show short and clumpy chromosomes. The cellular zone passes into the innermost zone which is formed by diffusely necrotic tissue. Between the necrotic masses are erythrocytes. Diagnosis, fibrosarcoma of the mesentery with central liquefaction.

Postoperative Course.—The patient was examined May 5, 1932, at which time he weighed 12 pounds more than before operation. He was free of symptoms. He entered St. Mary's Hospital July 7, 1935, complaining of swelling of the abdomen and the lower extremities, and died two days later. Autopsy showed general abdominal metastases diagnosed as spindle cell sarcoma.

The first survey of solid tumors of the mesentery was made by Harris and Herzog,[1] who reviewed the literature previous to 1897 and tabulated 56 reported cases in addition to one of their own. In 1920, Bigelow and Forman[2] reported a case and found some 100 cases recorded up to that time. The present survey discloses an additional 86 cases reported since 1920, thus bringing the total to approximately 186 cases.

In a report by Rankin and Major,[3] from the Mayo Clinic, the rarity of occurrence of these tumors is emphasized by the fact that only 22 were found among 820,000 patients admitted. Solid tumors of the mesentery are about evenly distributed between the sexes. In the cases reviewed there were 42 in the male, and 46 in the female. The age varies between 1 and 85 years.

The origin of mesenteric new growths is as effectively shrouded in mystery as is the etiology of tumors and cysts elsewhere. Rankin and Major[3] expressed the opinion that a certain number of them depend for their origin on congenital defects in the development of the mesentery. These authors discourse at some length upon the embryology of the mesentery and its morphologic relationship to neighboring structures. Trauma or previous diseases as etiologic agents were singularly lacking in all of the cases.

It is of interest to note the great variety of tissues found in tumors of the mesentery. It is small wonder, then, that pathologists find it difficult to agree as to the true nature of such diverse structures. The sections of the case here reported were shown to pathologists who did not agree to the diagnosis as given. One described the histopathology without giving a definite diagnosis. Similarly in several of the recorded cases the histopathology was given without statement of diagnosis. This is not surprising when one considers the structure of the mesentery. It is primarily a sheet of mesenchyme covered on both sides with mesothelium or endothelium, and from the mesenchyme there are derived all the fibrous connective tissues of the body. Running throughout this complex structure are nerve fibers, blood and lymph vessels and lymph nodes, any one of which may become the site of development of neoplastic formation.

Rawls[1] included the following tumors among the solid neoplasms of the mesentery: Lipoma, fibroma, carcinoma, and sarcoma. Bowers[5] states that of the solid tumors of the mesentery lipomata are the commonest, and fibromata the rarest. Among the total cases reported since 1920 the type and frequency are as follows: Lipoma, 12 cases; fibroma, 26 cases; sarcoma, 35 cases; cavernous hemangioma, 2 cases; teratoblastoma, 2 cases; lymphangioma, 1 case; lymphoma, 1 case; myxoma, 1 case; amyloid tumor, 1 case; osteosarcoma, 1 case; neuroma, 1 case; undesignated type, 2 cases; mixed mesodermal, 1 case.

The site of sarcomatous mesenteric tumors is, according to Szenes,[6] the mesentery of the small intestine in two-thirds of all cases. Murphy states that sarcomata show an especial predilection for the radix mesenterii, while the fibromata are generally found at the mesenteric attachment near the intestine. The greatest number have been described as occurring in the mesentery of the terminal portion of the ileum. However, cases are reported in which they have been found in the mesentery of the jejunum, the cecum, the appendix, and in all parts of the mesenteric coli. In one case the tumor occurred in such close relationship with the stomach that a resection of the stomach was done under the impression that it was a cancer of the stomach.

The cases may be divided into two groups with respect to symptoms: First, those cases which present few if any symptoms. The symptoms are here dependent on the size, the location, and the mobility of the growth. Even a large, slow growing tumor firmly held in the root of the mesentery may produce few symptoms. The few that are complained of may be due simply to the mechanical effects of the growth; *e.g.,* pressure, crowding, *etc.* Upon examining such a case a tumor may or may not be palpable. In the second group of cases there are rather frank abdominal symptoms varying in intensity from indigestion, dyspepsia, epigastric distress, general abdominal distress, gaseous distension, fulness, belching, constipation or diarrhea, loss of weight, and indefinite abdominal pains, to a sudden and acute abdominal attack, rapidly developing to the stage of the acute surgical abdomen. In this group are often met cases of acute intestinal obstruction; for instance, volvulus, intussusception, *etc.* One case of sarcoma of the mesentery is reported in which the patient was seized with a sudden acute abdominal attack requiring operation, and it was then discovered that there had occurred a severe hemorrhage into the peritoneal cavity from a ruptured blood vessel in the sarcomatous mass. Another case is reported in which the tumor ruptured, freeing intestinal contents into the peritoneal cavity, resulting in peritonitis. Often cases in this group come to operation with the mistaken diagnosis of acute appendicitis with or without abscess formation. This is readily understood since many of the tumors occur in the region of the terminal ileum.

The following case[7] illustrates the latency of the symptoms that are sometimes seen in the cases of Group 1: A patient presented himself for the removal of a sebaceous cyst in the abdominal wall. A tumor was discovered the size of a child's head in the right iliac fossa of which the patient had

TABLE I

SUMMARY OF CASES REPORTED DURING THE PAST FIFTEEN YEARS

Author	Where Recorded	History	Preoperative Diagnosis	Treatment	Postoperative Diagnosis	Result
Ransohoff, Louis J., and Friedlander, A.	ANNALS OF SURGERY, vol. 73, p. 211, February, 1921	Male, 73 yrs. of age. Palpable tumor	None	Resection	Fibrosarcoma of mesosigmoid	Recovery
Niosi, F.	Archiv. ital. di chir., Bologna, vol. 3, p. 657, July, 1921	Young woman. Acute abdominal attack	Ileus	Resection	Fibroma of the mesentery of the small intestine	Recovery
Alton, B. H.	Boston Med. and Surg. Jour., vol. 185, p. 205, August 18, 1921	Female, aged 60 yrs. Constipation and increasing abdominal distress	Mesenteric	No attempt made to remove because of extensive involvement	Biopsy, lipoma huge size	Recovery
Kyle, H. G.	Brit. Jour. Surg., vol. 9, p. 205, October, 1921	Male, 40 yrs. of age. Abdominal pain and increasing constipation	Mesenteric tumor	Resection	Fibroma of the mesentery of ileum	Recovery
Ecoffey, M.	Schweiz. med. Wchnschr., vol. 52, p. 202, February 23, 1922	Female, 85 yrs. of age. Dropsy. Arteriosclerosis, myocardial degeneration	None	None	None	Autopsy, found 2 amyloid tumors in the mesentery
Cartolari, E.	Gazz. d. osp., vol. 43, p. 271, March 19, 1922	Male, aged 28 yrs. Digestive disturbances	Primary tumor of mesentery	Tumor enucleated without resection	Sarcoma of mesentery near its origin	Recovery
Bell, George, and Inglis, K.	Med. Jour. Australia, vol. 1, p. 375, April 7, 1923	Male, 25 yrs. of age. Noticed a swelling in the abdomen for three weeks. Rapid growth	Retroperitoneal tumor	Resection of 93½ in. of ileum, cecum, ascending colon, and part of transverse colon	Spindle cell fibrosarcoma. Lower end of ileum	Recovery
Schmid. H. H.	Arch. f. Gynäk., vol. 118, p. 490, May, 1923	Female, aged 55 yrs. Palpable tumor in lower abdomen	Fibroma of uterus	Enucleation of the tumor without resection	Spindle cell sarcoma of the transverse mesocolon	Recovery
Avoni, A.	Arch. ital. di chir., vol. 7, p. 360, July, 1923	Male, aged 30 yrs. Abdominal distress. Pain in right hypochondrium	Cyst of mesocolon	Enucleation of tumor without resection	Round cell sarcoma of mesocolon. Size of fetal head	Recovery
Waser, B.	Schweiz. med. Wchnschr., vol. 53, p. 755, August 9, 1923	Female, 55 yrs. of age. Loss of appetite, loss of weight past 2 yrs.	None	Resection	Fibrosarcoma, size of child's head. Lower end of ileum	Died
Rawls, Julian L.	Virginia Med. Month., vol. 50, p. 764, February, 1924	Negress, aged 21 yrs. Pain in lower abdomen, bilateral. Palpable abdominal mass in midline	Malignancy of right ovary	Resection	Fibroma of the mesentery of lower end of the ileum	Recovery
Nossen, H.	Beitr. z. klin. Chir., vol. 132, p. 551, 1924	Female, 38 yrs. of age. Abdominal tumor discovered by her physician	None	Resection	Spindle cell sarcoma of mesentery of ileum. Size of child's head	Died fifth postoperative day

Author	Reference	Clinical data	Preoperative diagnosis	Operation	Pathological diagnosis	Result
Nossen, H.	Ibid.	Male, 58 yrs. of age. Pelvic tumor	None	Resection	Spindle cell sarcoma of the mesocolon. Size of child's head	Not stated
Nossen, H.	Ibid.	Male, aged 62 yrs. Intestinal and nutritional disturbance of years' duration. Abdominal tumor	Mesenteric tumor	Resection	Fibrosarcoma of mesentery of ileum. Size of fetal head	Recovery
Nossen, H.	Ibid.	Male, 23 yrs. of age. Abdominal pain and epigastric distress. Abdominal tumor in umbilical region	None	Resection	Round cell sarcoma of the mesentery of the ileum, size two fists	Recovery
MacAuley, Chas.	Irish Jour. Med. Sc., p. 54, February, 1925	Female, 29 yrs. of age. Vague abdominal discomfort with intermittent vomiting. Palpable abdominal tumor	Inflamed ovarian cyst	Resection	Fibroma of mesentery of lower end of ileum. Size of two fists	Recovery
deCourcy, J. L., and Maloney, J. J.	Surg., Gynec., and Obst., vol. 40, p. 402, March, 1925	Female, 25 yrs. of age. Pain and swelling in the right side of the abdomen	None	Resection	Fibroma of the mesentery of the ileum	Not stated
deElizalde, P. I., and Medeiros, J.	Semana med., vol. 1, p. 1405, June 25, 1925	Infant, 12 mos. of age. Abdominal tumor discovered at examination	None	Exploratory operation	Sarcoma of the mesentery of the ileum	Died at operation
Nigrisoli, P.	Arch. ital. di chir., vol. 13, p. 170, 1925	Female, aged 30 yrs. Epigastric pain, loss of strength, swelling in left flank for one month	None stated	Exploratory operation, impossible to remove the tumor because of adhesions. Biopsy	Blastoma of mesentery of the lower end of the ileum	Died five days later
Wassertrüdinger, O.	Arch. f. klin. Chir., vol. 137, p. 456, 1925	Male, aged 47 yrs. Acute abdominal attack. Palpable tumor, size of child's head, beneath right costal border	Acute cholecystitis, or atypical appendiceal abscess	Resection	Fibromyoma of the mesentery of the jejunum	Died one week later of pulmonary embolism
Cannon, D. J., and O'Kelly, W. D.	Irish Jour. Med. Sc., p. 571, December, 1925	Male, 3 yrs. of age. Palpable tumor in abdomen	Mixed tumor of right kidney	Enucleation without resection	Teratoblastoma of the mesentery of the lower end of the ileum	Recovery
Schürer-Waldheim, F.	Arch. f. klin. Chir., vol. 140, p. 601, 1926	Female, aged 44 yrs. Abdominal tumor, abdominal pain, loss of appetite. Duration 1 yr.	Omental or mesenteric tumor	Resection	Cystic sarcoma, size of fist, in mesenterial radix of ileum	Recovery
Piccinelli, A.	Policlinico, vol. 33, (sez. chir.), p. 322, June, 1926	Female, aged 2 yrs. Abdominal symptoms for 2 mos.	Abdominal tumor, tuberculoma, intussusception	Operation. What was done not stated	Mixed mesodermal tumor, mesentery lower end of ileum	Died 24 hrs. after operation
Brauneck, H.	Deutsche Ztschr. f. Chir., vol. 195, p. 345, 1926	Male, aged 27 yrs. Recently discovered a rapidly growing tumor in the umbilical region	None stated	Enucleation	Fibroma of mesentery of lower end of ileum. Size of fist	Recovery

TABLE I (*Continued*)

Author	Where Recorded	History	Preoperative Diagnosis	Treatment	Postoperative Diagnosis	Result
Gey, R.	Deutsche Ztschr. f. Chir., vol. 199, p. 341, 1926	Male, 68 yrs. of age. Acute abdominal attack. Tenderness in lower right quadrant	Acute appendicitis	Resection	Fibroma, mesentery lower end of ileum	Recovery
Mirer, W. J.	Arch. f. klin. Chir., vol. 143, p. 710, 1926	Male, 44 yrs. of age. Abdominal pains, blood colored vomitus, intestinal obstruction	Perforated ulcer; intestinal obstruction	Resection	Lipoma of lower end of ileum in its mesentery. Volvulus due to the tumor	Died 15 hrs. later
Baldwin, J. F.	Am. Jour. Surg., vol. 2, p. 160, February, 1927	Female, 24 yrs. of age. Operated elsewhere 1925. Diagnosis: Malignant retroperitoneal tumor. Merely closed abdomen. Later the recorder operated and discovered the true nature of the case	Retroperitoneal fibroma	Resection of 6 ft. of small intestine. Anastomosis using the Murphy button	Huge fibroma of the mesentery of the jejunum. Weight: 25 lbs.	Recovery
Bovin, Emil	Acta obst. et gynec. Scandinav., vol. 6, p. 135, 1927	Female, aged 29 yrs. Abdominal tumor, freely movable from side to side	Pedunculated myoma of uterus, or solid tumor of ovary	Enucleation	Fibromyoma, size of a child's head, in the mesocolon of the transverse and descending colon	Recovery
Polacco, E.	Beitr. z. klin. Chir., vol. 141, p. 102, 1927	Female, 26 yrs. of age. No symptoms. Palpable mass in the abdomen	None	Extirpated mass without resection of intestine	Neuroma racemosum in the great omentum and in the mesenteric radix	Recovery
Darnall, W. E.	ANNALS OF SURGERY, vol. 87, p. 870, June, 1928	Female, 25 yrs. of age. Tumor mass in the abdomen	None	Resection	Fibromata in the mesentery of the ileum	Died 9 hrs. postoperative
Bigelow, L. L., Scott, E., and Obenour, S. W.	ANNALS OF SURGERY, vol. 87, p. 879, June, 1928	Female, aged 8 yrs. Markedly distended abdomen	Tuberculous peritonitis	Exploratory laparotomy. Metastases in the liver, and entire mesentery filled with metastatic nodes	Lymphosarcoma of the mesentery of the lower end of ileum	Death 1 hr. postoperative
Ssokolow, N. N.	Deutsche Ztschr. f. Chir., vol. 210, p. 397, 1928	Male, aged 12 yrs. Epigastric pains and an abdominal tumor for 2½ mos.	Tumor of great omentum	Resection of the sigmoid	Fibroma of the mesosigmoid	Recovery
Grigorowsky, J. M.	Deutsche Ztschr. f. Chir., vol. 210, p. 390, 1928	Male, aged 19 yrs. For three months the patient had been aware of the presence of an abdominal tumor	Mesenteric tumor	Resection	Fibroma of the mesentery of the lower ileum, size of fetal head	Recovery
Cappellani, S.	La Clin. ostet., vol. 30, p. 576, August, 1928	Female, 57 yrs. No symptoms. Palpable tumor in the left side of the abdomen	Solid tumor of the left ovary	Enucleation without resection	Fibrosarcoma of the mesocolon	Recovery

Author	Reference	Clinical history	Preoperative diagnosis	Operation	Pathological diagnosis	Result
Schmitt, W.	Zentralbl. f. Gynäk., vol. 53. p. 719. March 23. 1929	Female, aged 21 yrs. Palpable tumor, size of fetal head, on the left side of the abdomen	None	Resection	Cavernous hemangioma of the mesosigmoid	Recovery
Frank, Louis	Kentucky Med. Jour., vol. 27. p. 169, April, 1929	Male, aged 28 yrs. Abdominal tumor for 12 yrs. Sudden acute abdominal attack	Appendicitis, with peri-appendiceal abscess. Intestinal obstruction	Resection	Mesenteric tumor of the lower ileum (histologic variety not stated)	Recovery
Courty, L., and Falala, C.	J. de chir., Par., vol. 33. p. 473. April, 1929	Male, 44 yrs. of age. Came in to have a sebaceous cyst removed from the abdominal wall. His physician discovered a large abdominal tumor which patient did not know existed	None	Resection	Fibroma of the mesentery of the lower ileum	Recovery
Tourneux, J. P.	Presse méd., vol. 37. p. 593. May 4. 1929	Male, 48 yrs. of age. Palpable tumor and movable. Recurrent abdominal pain	Tumor of mesentery	Enucleation	Fibroma of mesentery	Recovery
Fisher, W. H.	Am. Jour. Surg., vol. 7, p. 803, December, 1929	Female, aged 37 yrs. Backache and radiating pains, 2 yrs. duration. Solid mass in vault of vagina	Retroperitoneal growth	Enucleation	Encapsulated mesenteric fibromyoma in the pelvic mesocolon	Recovery
Ramselaar, C. G.	Nederl. tijdschr. v. geneesk., vol. 74. p. 2392. May 10. 1930	Male, 52 yrs. of age. Acute retention of urine. Palpable abdominal tumor	Tumor of the small intestine of unknown origin	Resection	Fibrosarcoma of the mesentery of the lower ileum, tumor was necrotic	Recovery
Crane, Whitfield	Am. Jour. Surg., vol. 9, p. 441. September, 1930	Female, aged 30 yrs. Intermittent dull pain in the lower abdomen for past six months	Abdominal tumor	Enucleation without resection	Lymphangioma of the mesentery of the lower ileum	Recovery
Matthaes	Deutsche Ztschr. f. Chir., vol. 224. p. 98. 1930	Male, 22 yrs. of age. Acute abdominal crisis	Perforated abdominal viscus, with peritonitis	Resection	Sarcoma of the mesentery of the lower ileum	Died of postoperative pneumonia
Antoine, T.	Arch. f. klin. Chir., vol. 160, p. 458, 1930	Female, 24 yrs. of age. Pregnant 7 mos. "Yellow vomitus" and abdominal pain for past 8 mos.	Ovarian tumor, or pedunculated fibroid with twisted pedicle	Resection	Fibroma of the mesentery of the lower ileum. Gangrenous bowel	Recovered from the operation; premature labor, delivered, died 1 hr. later
Masumoto, K.	Tr. Jap. Path. Soc., vol. 21, pp. 844–845, 1931	Female, aged 57 yrs. Palpable tumor. Colic-like pains throughout abdomen. Vomiting	Movable tumor	Exploratory	Spindle cell sarcoma in mesentery of jejunum	Died
Masumoto, K.	Ibid.	Female, aged 51 yrs. Pain and swelling in abdomen for one year. Slow growing tumor	Tumor of lymph nodes	Exploratory. Biopsy	Spindle cell sarcoma in mesentery of small intestine	Died

TABLE I (*Continued*)

Author	Where Recorded	History	Preoperative Diagnosis	Treatment	Postoperative Diagnosis	Result
Simoes Trincao. M.	Med. contemp., vol. 49, p. 73. March 1, 1931	Female, aged 60 yrs. Severe pain in the upper abdomen, palpable abdominal tumor, ascites, diarrhea	Tumor of the alimentary tract	Paracentesis to relieve the ascites, otherwise symptomatic only	Sarcoma in the transverse mesocolon	Postmortem examination
Vozza, F.	Ann. di ostet. e ginec., vol. 53. p. 501, May 31, 1931	Female, aged 34 yrs. Fulness and distention of the lower left quadrant for 2 mos., abdominal swelling for 10 yrs. Pregnant	Dermoid cyst	Enucleation	Neurolipoma, the size of an orange, in the mesocolon of the descending colon	Recovery
Bergareche, J.	Arch. de med., cir. y especialid., vol. 34. p. 1017, November 7, 1931	Male, aged 42 yrs. Movable tumor in the abdomen for 6 mos., increasing size of abdomen	Mesenteric tumor	Resection	Fibrosarcoma in the mesentery of the small intestine	Recovery
Martinez, M.	Bol. Soc. de cir., Chile, vol. 10, p. 10, April 13, 1932	Female, aged 42 yrs. Gradual enlargement of abdomen for 4 yrs. Vomiting and continuous pain	Hydatid cyst of mesentery	Enucleation	Lipoma of descending mesocolon	Recovery
Pellicia, G.	Ann. ital. di chir., vol. 11, p. 949, August 31, 1932	Female, aged 26 yrs. Dull pain in both loins for 2 mos., loss of weight. Acute abdominal attack	Acute appendicitis	Enucleation	Fibrolipoma of the mesentery of the terminal ileum	Recovery
Judd, E. S., and Crisp, N. W.	Proc. Staff Meet., Mayo Clinic, vol. 7, p. 555, September 21, 1932	Female, aged 53 yrs. Fulness in lower abdomen for 6 mos. Worse when lying down	Mesenteric tumor	Enucleation	Fibroma in mesentery of jejunum	Cured
Summers, J. E.	Surg., Gynec. and Obst., vol. 55, p. 244, August, 1932	Female, aged 3 yrs. Mother discovered movable tumor in abdomen one month before examination by physician	Mesenteric tumor	Enucleation	Fibroma in mesentery of jejunum	Recovery
McCalla, L. H.	Jour. South Carolina Med. Assn., vol. 28, p. 211, August, 1932	Female, aged 70 yrs. Mass in lower abdomen	Pelvic malignancy	Resection	Fibroma in mesentery of lower ileum	Recovery
Counseller, V. S., and Cox, F. W.	Surg. Clin. N. Amer., vol. 12, p. 1033, August, 1932	Female, aged 34 yrs. Swelling in abdomen for 2 mos.	Pedunculated fibroma	Resection	Fibroma in the leaves of the mesentery at the junction of jejunum and ileum	Recovery
Pintos, C. M. and Murtagh, J. J.	Semana med., vol. 2, p. 1531, November 24, 1932	Female, aged 2½ yrs. Rapidly growing abdominal tumor for 2 mos., jaundice	Hydatid cyst, tuberculous peritonitis, neoplasm	Symptomatic only	Lymphosarcoma in the mesocolon with metastasis	Postmortem examination

Author	Reference	Clinical data		Treatment	Tumor	Result
Rankin, F. W., and Major, S. G.	Surg., Gynec., and Obst., vol. 54, p. 800, May, 1932	Female, aged 57 yrs. Swelling in abdomen 2 mos. duration. Palpable mass	Not stated	Not stated	Lipoma in mesentery 6 ft. from duodenojejunal junction	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Female, aged 28 yrs. Palpable mass in abdomen for 6 mos.	Not stated	Not stated	Lipoma in mesentery of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Female, aged 38 yrs. Pain in lower abdomen for 2 mos.	Not stated	Not stated	Lipoma in mesosigmoid	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 46 yrs. Pain in upper abdomen for several years. Palpable tumor for 2 mos.	Not stated	Not stated	Multiple fatty tumors of mesentery of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Female, aged 46 yrs. Abdominal distress for 6 mos.	Not stated	Not stated	Lipoma in mesentery of upper part of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Female, aged 25 yrs. Dull intermittent pain in abdomen. Palpable mass in abdomen for 18 mos.	Not stated	Resection	Fibroma in mesentery of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 50 yrs.	Not stated	Not stated	Fibroma in mesentery of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 45 yrs. Palpable mass. Pain in lower abdomen for 4 mos.	Not stated	Resection	Fibrolipsarcoma in mesentery of small intestine	Recovery
Rankin, F. W., and Major, S. G.	Ibid.	Female, aged 68 yrs. Distress in lower abdomen for 3 yrs.	Not stated	Enucleation	Fibromyosarcoma in mesentery of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 54 yrs. Loss of weight. Epigastric distress for 6 wks.	Not stated	Inoperable. Palliative intestinal anastomosis	Biopsy. Fibrosarcoma of mesentery	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 44 yrs. Loss of weight. Abdominal distress for 8 mos.	Not stated	Not stated	Fibrosarcoma in mesentery of small intestine	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 40 yrs. Loss of weight. Shooting pains in lower abdomen for 18 mos.	Not stated	Not stated	Low grade myxoma in mesentery of jejunum	Not stated
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 53 yrs. Loss of strength, constipation, bloody stools, soreness in lower abdomen for one year	Not stated	Enucleation	Spindle cell sarcoma in mesentery of ileum	Returned 6 yrs. later with metastasis of the liver
Rankin, F. W., and Major, S. G.	Ibid.	Male, aged 56 yrs. Dull lower abdominal pain. Three attacks of colic in past 5 years. Acute abdomen developed. Emergency operation	Not stated	Not stated	Multiple degeneration of sarcomatous cyst in mesentery of small intestine. Ruptured with peritonitis	Died 6 days after operation

TABLE I (*Continued*)

Author	Where Recorded	History	Preoperative Diagnosis	Treatment	Postoperative Diagnosis	Result
Rankin, F. W., and Major, S. G.	Surg., Gynec. and Obst., vol. 54, p. 809, May, 1932	Male, aged 60 yrs. Increasing constipation, 2 yrs. loss of weight	Not stated	Inoperable. Biopsy	Very malignant myxosarcoma in mesentery of small intestine	Not stated
Ambrumyants, G. N.	Sovet. khir., vol. 4, p. 610, 1933	Male, 5 yrs. of age, slowly enlarging tumor since birth, daily vomiting	Intraperitoneal tumor	Resection of 12 ft. of the small intestine	Diffuse cavernous hemangioma in the mesentery of the small intestine	Died 5 mos. later of continuous diarrhea
d'Abreu, F.	Brit. Jour. Surg., vol. 21, p. 212, October, 1933	Female, aged 22 yrs. Acute abdominal attack	Acute appendicitis	Resection. End-to-end anastomosis	Lipoma in mesentery of small intestine	Recovery
Montemartini, G.	Gazz. internaz. med.-chir., vol. 41, p. 584, October 15, 1933	Male, aged 30 yrs. Diffuse pain in abdomen for 1½ mos. Palpable tumor	Mesenteric neoplasm	Enucleation	Spindle sarcoma of the omentum	Recovery
Gruhn, G.	Folia haemat., vol. 49, p. 268, 1933	Male, aged 64 yrs. Palpable tumor in upper abdomen, left side. Clinical picture of polycythemia	Not stated	Symptomatic only	Sarcoma of the mesocolon	Died, postmortem examination
Diaz, F., and Rivero, L.	Gac. med. de Caracas, vol. 40, p. 357, December 31, 1933	Female, aged 24 yrs. Rapidly growing tumor in abdomen for 2 mos.	Malignancy of ovary	Resection	Malignant tumor (variety not stated) of the mesentery of the ileum	Recovery
Bordeianu, I.	Rev. de chir. Bucuresti, vol. 36, p. 262, July-August, 1933	Male, aged 65 yrs. Abdominal pain for several months. Sudden acute attack of intestinal obstruction	Acute intestinal obstruction	Emergency laparotomy, tumor enucleated	Fibrosarcoma in the mesocolon	Died 5 hrs. later
Grapiolo, A. C., and Palazzo, R.	Rev. sud-am. de endocrinol., vol. 16, p. 627, August 15, 1933	Male, middle aged. Pain in the liver region, abdominal distention. Acute lung symptoms. Pleural effusion	Not stated	Symptomatic only	Lymphosarcoma of the mesentery in the region of the pancreas, highly malignant	Died, postmortem examination
Perrardo G.	Arch. ital. d. mal. d. app. diger., vol. 2, p. 415, October, 1933	Male, aged 50 yrs. Pain in the epigastric region for 10 yrs.	Retroperitoneal tumor	Resection	Myxosarcoma in the mesocolon of the transverse colon	Death from metastasis 11 mos. later
Weaver, O. H.	Jour. Med. Assn. Georgia, vol. 22, p. 295, August, 1933	Negro. Female, aged 10 yrs. Swelling in abdomen	Mesenteric tumor	Resection	Fibroid tumor in transverse mesocolon	Recovery
Walters, W., and Priestley, J. T.	Surg. Clin. N. Amer., vol. 14, p. 643, June, 1934	Male, aged 34 yrs. Pain in lower abdomen for 8 yrs. Loss of appetite and weight. Relieved until 1932 when symptoms returned. Palpable tumor	Urachal carcinoma	Enucleation	Tumor in mesosigmoid	Recovery

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ble tumor

Author	Reference	History		Operation	Tumor	Result
Walters, W., and Priestley, J. T.	Ibid.	Male, 60 yrs. of age. Recurrent attacks of pain in the upper abdomen for 6 wks. Nausea and vomiting. Palpable tumor	Not stated	Inoperable. Biopsy	Huge lipoma in mesentery of jejunum	Not stated
Phillips, H. A.	Brit. Jour. Surg., vol. 21, p. 637, April, 1934	Female, aged 63 yrs. Swelling in abdomen for 4 yrs.	Not stated	Enucleation	Spindle cell tumor in gastrohepatic ligament	Death 24 hrs. later
Phillips, H. A.	Ibid.	Female, aged 73 yrs. Swelling in right iliac fossa for 4 mos.	Not stated	Exploratory. Biopsy	Spindle cell tumor in great omentum	Died 8 weeks later
Kubo, M.	Mitt. a. d. med. Akad. zu Kioto, vol. 11, p. 302, 1934	Male, aged 30 yrs. Abdominal pain and tumor for 5 mos.	Not stated	Exploratory operation. Biopsy. Roentgen ray therapy	Osteosarcoma in the mesentery of the ileum	Died 55 days later
Finzi, O.	Boll. e mem. Soc. piemontese di chir., vol. 4, p. 1760, 1934	Female, aged 32 yrs. Slow growing tumor in right hypochondrium	Not stated	Resection of the terminal ileum, cecum, ascending colon and a part of the transverse colon	Fibroma of the mesocolon of the ascending colon	Recovery
van der Spek. J.	Nederl. tijdschr. v. geneesk., vol. 78, p. 5833, December 29, 1934	Male, 20 yrs. of age. Enlargement of the abdomen for 2 mos.	Abdominal tumor	Ileocecal resection	Fibromyoma in the mesentery of the terminal ileum	Died fourth postoperative day

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been unaware. This was removed together with 36 inches of the small intestine. The histologic diagnosis was fibroma of the mesentery. At any time the "silent" variety may, as a result of some intra-abdominal accident, become active and the patient likewise be seized with an acute abdominal attack necessitating surgical intervention.

An early diagnosis of tumors of the mesentery is desirable. Bearing the condition in mind as a possibility is the first requisite in making a correct diagnosis. The early literature on the subject calls attention to the difficulty of correct preoperative diagnosis. Ransohoff and Friedlander[8] state that the clinical diagnosis of mesenteric tumors is practically an impossibility. They further state that there are no pathognomonic signs or symptoms. Of the 86 cases reviewed and summarized in Table I, it is seen that the condition was correctly diagnosed 14 times before operation. It is not too much to suppose that the number of correct diagnosis would have been greater had the condition been considered and the examination directed with this thought in mind.

In several recorded cases of tumor of the mesentery the difficulties were so great and the appearances so puzzling that the operators did not recognize the true condition with the abdomen opened and the tumor before them. One merely closed the abdomen thinking the condition was malignant and inoperable; another failed to recognize the true nature of a huge lipoma of the mesentery and he likewise closed the abdomen. Both of these cases were later successfully operated upon elsewhere.

A "silent" but palpable abdominal tumor which may or may not be found in the region of the radix mesenterii, movable from side to side but not in an upward and downward direction, and that by roentgenologic examination can be shown to be extrinsic to the gastro-intestinal and the urinary tracts, should at least be suggestive of mesenteric pathology. In cases complicated with an intra-abdominal disaster the tumor may or may not be palpable and if there is a preëxisting history of a tumor with the above characteristics the true condition should likewise be thought of.

An added difficulty in diagnosis will arise in females where the possibilities of pelvic tumor must be considered. However, the nature of the majority of such growths can be determined by a careful pelvic examination. By placing the patient in a Trendelenburg position and thus utilizing the effect of gravity on structures outside of the pelvis, one will often be assisted in concluding whether or not the tumor originates in the pelvic structures. Reported cases of recent years indicate that correct preoperative diagnosis are being made more frequently.

The majority of solid tumors of the mesentery are benign and hence successful surgical removal will give a favorable prognosis. The degree of malignancy here is as a rule of a low grade. Metastases, with few exceptions, do not occur early. However, the cases should be watched for recurrences four, six, and ten years later. One of the cases reported by Rankin

and Major returned to the clinic six years after the primary operation with metastases in the liver.

Needless to say, the treatment of this condition is entirely surgical. Removal of the tumor with or without resection is the sine qua non to successful treatment, and this can be determined only at the time of the operation with the abdomen opened. If the tumor is so situated that it can be shelled out of the leaves of the mesentery without jeopardizing the blood supply to the adjacent bowel, resection of the intestine will then not be necessary. However, this may be a difficult matter to decide, and when in doubt it is safer to resect.

The question of resection of the bowel is not necessarily determined by the size of the tumor as evidenced by the case cited by Doran[9] in which a fibroma weighing 30 lbs. was successfully enucleated without a resulting impairment of the blood supply to the intestine. The length of intestine removed has varied from a few inches to eight feet.[10]

The tumor may also be firmly attached to the surrounding structures by dense adhesions and hence the surgeon's judgment, dexterity and patience be taxed to the utmost. However, as Dr. W. D. Haggard has so fittingly stated, "The master craftsman in surgery, knowing the merits and prudence of each procedure, will unerringly select the correct method for the good of the patient."

SUMMARY

A case of fibrosarcoma of the mesentery is reported together with a review of the literature on the subject of solid tumors of the mesentery for the past 15 years. It is estimated that approximately 186 cases have been recorded up to the present time.

There is not always a unanimity of opinion among pathologists as regards the histopathologic diagnosis of solid tumors of the mesentery.

The cases present one of two groups of symptoms; one, the "silent" tumor with few if any symptoms, and two, those having vague abdominal symptoms of increasing importance up to the acute surgical abdomen produced by the mechanical effects of the tumor or rupture with hemorrhage and peritonitis.

As a rule, the malignancy of such tumors is of a low grade, but the cases should be observed for recurrence years later.

The diagnosis before operation is being made more frequently in recent years so that the correct preoperative diagnosis is no longer purely a matter of good fortune but of design.

The problem in treatment is to decide whether the tumor can be removed with or without resection of the involved segment of intestine.

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MECHANISM AND SIGNIFICANCE OF OBLITERATION OF THE LUMEN OF THE VERMIFORM APPENDIX*†

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A study of the mechanism of obliteration of the vermiform appendix was undertaken in an effort to answer the following questions raised in reference to appendiceal obliteration:—Does obliteration of the appendix result from normal physiologic involution or is it caused by inflammation; or is it a combination of both of these processes? Just how does the appendix obliterate? Why is the appendix the only structure of the adult gastro-intestinal tract to undergo an obliteration of its lumen? Is the presence of lymphoid tissue in the submucosa of the appendix of significance? Why should the appendix possess comparatively more lymphoid tissue than found elsewhere in the intestinal canal? How should one regard the so called "reaction centers" in the appendiceal lymph follicles? Why should the appendiceal submucosa be the only portion of the intestine to contain large amounts of adipose tissue? What is the origin of this adipose tissue?

Can Masson's[11] contentions that neuromata formation plays an important rôle in obliteration be substantiated? Is he correct in his assumption that the sympathetic nervous plexuses play a major rôle in the formation of new connective tissue in obliterated appendices? Do Mallory's[10] views on the importance of endothelium in the production of new connective tissue apply in the case of appendiceal obliteration? Are lymphocytes a factor in this obliterative process? How are we to evaluate Maximow's insistence of the polyblastic abilities of lymphocytes? Is there any relationship between obliteration and the so called "carcinoids" of the vermiform appendix? Finally, what should be the attitude of the surgeon when encountering an obliterated appendix during an abdominal exploration? What is the clinical significance of such an obliterated appendix vermiformis?

The source of the data upon which this study is presented was derived from 1,054 appendix specimens obtained from consecutive unselected post-mortems conducted in the Section on Pathologic Anatomy of the Mayo Clinic. This material was collected in a period of one and one-half years. Three hundred additional appendices were studied during a six months' period in the Section on Surgical Pathology at St. Mary's Hospital, Rochester, Minn. These two sources afforded a means of comparison between post-mortem and surgically removed appendices. It was noted that more surgically

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removed appendices were obliterated and showed more definite signs of inflammation than those removed during the performance of a routine post-mortem examination, in the same age groups. This is what one would naturally expect to find, since the surgical specimens had been removed because of either a history of or signs of appendicitis.

The following procedures were employed with the postmortem appendices: —Upon opening the abdominal cavity, the position and the relationship of the appendix to neighboring abdominal contents was carefully noted *in situ* before the abdominal contents were disturbed. Adhesions, "Jackson's veil" and "Lane's kink" were carefully studied and their incidence tabulated. Examples of the failure of the cecum to rotate or to descend into the right lower quadrant of the abdomen were carefully observed. The ceca were classified into one of the four types of Treves'[16] classification. The appendix was then measured as to its length and average diameter. The specimen was then removed at the appendicocecal junction. Three routine transversely cut blocks of tissue were taken from each appendix. The levels for the three blocks were as follows: 1 cm. from the tip of the appendix, through the middle third of the specimen, and lastly through the proximal third, ½ cm. from the appendicocecal junction. Two sections were cut from each of the three blocks of tissue, one being stained with hemotoxylin and eosin and the other section with Van Gieson's connective tissue stain. The first stain depicted the finer cellular details, while the latter was of great value in studying the amount of connective tissue present and the relationship it bore to the process of obliteration. If interesting gross specimens were found showing important pathologic conditions, they were first photographed before microscopic study was undertaken. After the gross tissue blocks were cut for microscopic study, the remaining portions of the appendix were slit open with a pair of fine blunt-pointed scissors and the gross condition of the mucosa and lumen was noted. Abnormalities were searched for. In each instance a gross diagnosis was made as to whether or not any obliteration of the lumen was present and later compared with the microscopic findings. The diagnosis was correct in only 61 per cent of the gross estimations as to the presence or absence of lumen obliteration. The error occurred, in the great majority of instances, in failing to recognize the very early degrees of lumen obliteration. Careful records were kept of the gross and microscopic findings in each specimen together with a review of the history of the patient and the chief pathologic findings discovered at postmortem. If upon microscopic examination interesting findings were encountered, new sections were cut from the original tissue blocks and various other specific stains were employed to delineate more clearly the cellular details. The following special stains were used: Mallory's aniline-blue, Mallory's phospho-tungstic acid, Brown's modification of the Gram-tissue stain, specific stains for elastic and collagenous connective tissue, and various silver stains designed to bring out neurogenic details. The microscopic sections of the material studied totaled approximately 14,000.

Some of the findings derived from this study are as follows: approximately 61 per cent of this series of 1,054 specimens had patent lumina, while 39 per cent showed varying degrees of lumen obliteration; 61.4 per cent were males and 38.5 per cent were females; 58.6 per cent of the appendices were either anterior or hung free in the abdominal cavity while the remaining 41.4 per cent were bound down in a retrocecal position. In the specimens derived from those whose age was less than 50 years, more appendices were stenosed and still contained lymph follicles in varying degrees of preservation. This latter observation shows that the appendices were for the most part either just obliterating or had recently become stenosed. This fact argues that probably inflammation brought these changes about, because it is still rather early for physiologic involution of the lumen and appendix.

Seventy-five point eight per cent of this series contained specimens which measured between 5 and 9 cm. in length. In this study, the 648 male appendices averaged 7.4 cm. in length while the average length of the 406 female specimens was 6.7 cm. Thus, the male specimens averaged 0.7 cm. more in length. This peculiar fact had been previously noted by Berry[2, 3] and by Fawcett and Blatchford[5] in smaller series of cases. Seventy point four per cent of the series were derived from individuals between the ages of 30 and 70, the appendices being fairly equally divided among the four decade age groups.

The fact that more than 50 per cent of the specimens in each age group were not obliterated until the seventh decade was reached clearly shows that the theory of the involutionary origin of appendiceal lumen obliteration cannot entirely explain the mechanism of such a process. Even in the ninth decade of this series, 35.0 per cent were still patent in their entirety. Little actual lumen stenosis began before the age of 40 years. In the first four decades at least 71.1 per cent of each age group had completely patent lumina. It was not until the fifth decade was reached that total obliteration of the specimens actually appreciably began. Above the age of 50 years, obliteration is fairly equally divided between that involving the distal third, the distal two-thirds and that of the entire appendix.

The earliest obliteration of the distal third of a specimen in this series was found in an eight and one-half months old fetus. The latest obliteration confined to the tip alone was present in an appendix of an individual aged 84. The earliest total obliteration of a specimen occurred at the age of 12, while the oldest total lumen stenosis was discovered in a specimen obtained from a male whose age was 96. The ages in this series for the various types of obliteration are much greater than those reported by MacCarty and McGrath which they had derived from surgically removed specimens. This is what one would naturally expect to find when a comparison is attempted between these two different sources of anatomic material. This fact also suggests that obliteration of the appendiceal lumen must occur usually years earlier than when the postmortem specimen was obtained.

It is only above the age of 40 that total lumen obliteration is present to any appreciable degree in the specimens, varying from 10.4 per cent at the

age of 40 to 12.8 per cent at the age of 80. In the ninth decade this figure
rose to 25.0 per cent, while in the tenth decade it was 100.0 per cent. How-
ever, in the ninth and tenth decade age groups there were only 21 specimens
and consequently these percentages are of little significance. It was found
that 39.08 per cent of the entire series had either partial or complete oblitera-
tion of the lumen. This is a considerably higher figure than those given in
the literature. This wide discrepancy is probably explainable on the basis
that in this series many early partially obliterated specimens were discovered
only upon microscopic study. Grossly, there was failure to recognize 35.1
per cent of the appendices showing early lumen stenosis.

The percentage of all types of lumen occlusion in each age group rose
steadily from 3.1 per cent in the first decade to 65.0 per cent in the ninth decade.
However, between the third and ninth decades, the percentage for obliteration
of the distal third of the lumen only varied between 20.8 and 22.0 per cent.
This suggests that obliteration probably began early in adult life from inflam-
matory processes. Of the 412 examples of lumen stenosis obtained from this
study, 22.74 per cent occurred before the age of 40, while 80.58 per cent were
between the ages of 30 and 70. Only 7.92 per cent of these instances of
obliteration were encountered under the age of 30, whereas merely 12.24 per
cent occurred after the age of 70.

There were 254 appendices (24.2 per cent) less than 6 cm. in length. From
the material of this study, the shorter specimens revealed higher percentages
of obliteration than did those specimens whose length was greater than 6 cm.
This percentage varied from 66.0 per cent for appendices 1 cm. long to 53.4
per cent for those 5 cm. in length. The average percentage of lumen occlu-
sion for these short forms was 45.8 per cent; while the average for the
remainder of the specimens 6 cm. or more in length, was 29.6 per cent.

Thirty-two point five two per cent of the anteriorly situated appendices were
stenosed, while 48.39 per cent of the retrocecal specimens had a similar lumen
atresia. Seventeen point one five per cent of the anterior cases and 18.34 per
cent of retrocecal types possessed occlusion of the distal third of the lumen.
Seven point nine two per cent of the anteriorly situated specimens and 14.67 per
cent of the retrocecal forms had lumen obliteration of the distal two-thirds.
Only 7.44 per cent of the anterior appendices were totally obliterated, whereas
15.36 per cent of the retrocecal cases presented a similar finding. These
figures show that more retrocecal specimens were obliterated than were the
free anterior forms. Since obliteration of the vermiform appendix is usually
caused by a previous inflammation, therefore probably more retrocecal speci-
mens were originally subjected to inflammation than were the free anterior
cases. Undoubtedly many retrocecal appendices derived their location from
a previous inflammatory process.

Thirty-two appendices (3.08 per cent) of the 1,054 specimens of this study
demonstrated abnormal types of lumen stenosis, in that the occlusion was not
progressing continuously, as it ordinarily does, from the tip towards the
base. Eighteen specimens (56.8 per cent) of this group revealed the most
marked obliteration of the lumen to occur in the middle third of the appendix.

Four instances (12.5 per cent) were encountered in which the tip and base were obliterated, but the middle third of lumen of the specimen was patent. Five examples (15.6 per cent) of occlusion were found where the process was most advanced in the proximal third. In two appendices (6.25 per cent) the proximal third of the lumen was the only portion to be obliterated. Three instances (9.37 per cent) were obtained in which the middle third only of the lumen revealed lumen atresia.

Five "carcinoid tumors" (0.47 per cent) were found in the 1,054 specimens. All were situated in obliterated portions of the former appendiceal lumen. In four instances the tumor occurred near the tip of the appendix, while the remaining case was situated near the appendicocecal junction. Thus, one "carcinoid" occurred to every 82 plus obliterated specimens. MacCarty and McGrath[9] found the incidence to be one "carcinoid" to 53 partially or totally obliterated appendices.

There are apparently two chief processes by which the inflammatory type of obliteration of the appendiceal lumen may develop. The first is the more common. Following an attack of acute or subacute appendicitis which subsides by resolution, the mucosa is either partially or totally destroyed and the inflamed portions of the lumen, now unprotected by a lining of mucosa, adhere together and later become solidly fused. The crypts of Lieberkühn, which are the source of new mucosal regeneration, cease to function in this capacity and are destroyed. They then undergo atrophy and rapidly disappear. It is believed that the extensive loss of the mucosa is responsible for the rapid destruction of the crypts. In the newly obliterated appendiceal lumen, a large number of lymphoid follicles and considerable collections of small lymphocytes alone are remainders of the necrotic mucosa and portions of the submucosa. Under the stimulus of repair following inflammation, the polyblastic tendencies of the reticular endothelium and lymphoid tissue quickly become manifest. The "reaction-centers" of the lymph follicles rapidly disappear. The follicles themselves persist for considerable periods of time after the obliteration of the appendiceal lumen has occurred.

A typical inflammatory type of coarse reticular connective tissue is derived from the large amount of submucosal reticulum remaining as well as from endothelium and fibroblasts present in the interfollicular layer of the submucosa. A further important source of this new tissue originates from the vascular and lymphoid sinusoidal endothelium as well as from lymphocytic tissue. This newly formed coarse reticular connective tissue, as it grows older, changes into hyaline-collagenous connective tissue. Usually large portions of the submucosa are destroyed by the primary acute or subacute inflammation responsible for the lumen obliteration. This leaves in its wake a skeletal framework of supporting hyaline connective and reticular endothelial tissues which were originally present in the submucosa. Soon the intervening spaces in this scaffolding are filled by adipose tissue, derived mostly from normal fatty tissue of the meso-appendix. This new adipose tissue probably enters the area of the submucosa by migration in along the perforating blood

vessels. Some of this new tissue may originate from the submucosal lymphoid-endothelial-reticular structures.

The formation of reticular connective tissue increases as lymphocytic tissues present in the obliterated lumen region disappear. This newly formed connective tissue spreads in a stellate manner through the submucosa from the former site of the lumen peripherally towards the juncture with the circular muscularis. This juncture between the submucosa and the muscularis is the last portion of the submucosa to be replaced by recently formed hyaline connective tissue. The farther away the connective tissue is from the former site of the appendiceal lumen, the older it is and the greater is the likelihood that it will be of a hyaline-collagenous type. Elastic connective tissue is usually not encountered in appreciable amounts in obliterated appendices.

The newly formed inflammatory type of reticular and collagenous connective tissues can be readily distinguished from the normally present older reticulum and hyaline collagen. In the newer tissues, the following histologic details may be readily recognized: the fibrils and fibers are coarser, the nuclei are larger and present immature histologic characteristics; the cytoplasm is more granular and contains large numbers of fine fibrils in its composition; and finally, these tissues characteristically stain a lighter color with specific connective tissue stains than do normally present hyaline connective tissue elements. The type of reticulum and collagen encountered in an obliterated appendiceal lumen is quite comparable to that observed in granulation tissue and in scars that heal by secondary intention elsewhere in the human body. This is a further argument in favor of its inflammatory origin.

The second process of appendiceal obliteration is less commonly seen. It is in reality only a modification of the first type and the basic principles responsible for the ultimate obliteration of the lumen are the same. In this group the mucosa has been subjected to numerous mild subacute inflammations which were insufficient to totally destroy it, however, enough areas of the mucosa and submucosa are injured from time to time to initiate the endothelial, lymphoblastic and fibroblastic formation of new reticular tissue, in either large or small amounts, depending upon the degree of stimulus derived from the inflammation. Often the inflammatory process may cause a thrombosis of the submucosal blood vessels with a resultant localized infarction of areas of the submucosa and mucosa. After several such incidents, the lymphoid tissue bordering the limits of the lumen is markedly reduced. The submucosa is replaced with considerable collections of hyaline collagenous connective tissue and with a minimum of reticular tissue. The lumen is markedly narrowed by this hyaline connective tissue proliferation. Finally, the lumen is obliterated in one of the following two ways: (1), by the pressure atrophy of the mucosa resulting from encroachment of the increasing hyaline connective tissue originating from inflammatory stimulated submucosal tissues and from preexisting hyaline connective or endothelial tissue elements; (2), by an additional acute inflammation which finally destroys so much of the mucosa that it cannot be regenerated by the decreased number

of functioning crypts of Lieberkühn, before adhesion to the opposite wall occurs.

Various modifications of these two processes may be encountered in a large group of specimens. However, the mechanism of the formation of the lumen occlusion is fundamentally the same. Localized acute inflammations of the lumen may totally destroy narrow areas of the mucosa and cause the formation of the so called "diaphragmatic" or "thick" occlusions of Maale.[7] If such a process occurs near the appendiceal base and if the portion distal to the resultant limited obliteration has an intact mucosa and can overcome the residual inflammation present in the now sealed off cavity, a mucocele of varying size may result. If the resulting cavity is unable to cope with the inflammation remaining in the lumen, an acute fulminating gangrenous appendicitis with probable perforation may result.

In this study it soon became apparent that the only specimens in which to intensively study the histologic changes occurring in obliteration were those either just undergoing obliteration or the junction line of those in which obliteration was slowly extending from the tip towards the base. Both types of material were studied, using many varieties of histologic stains to bring out selectively all of the component tissues. It was soon noted that the neurogenic tissues in the specimens were not responsible for the lumen atresia. Many types of nerve tissue stains were used before reaching this conclusion. In no specimen could Masson's contentions be substantiated. Therefore, attention was focused upon the histologic appearance of early beginning obliteration and upon the junction zone between the obliterated and patent portions of the lumen, in an effort to learn how obliteration originated.

In specimens showing early beginning obliteration of the entire lumen, the following histologic details are commonly seen: there are large collections of small lymphocytes, plasma cells, mast cells, polymorphonuclear eosinophils, monocytes, fibrocytes, endothelial cells and histocytes found largely in the submucosa, obscuring the normal histologic details of the appendiceal wall. The greatest aggregations are found in the interfollicular layer of the submucosa. Isolated groups of small lymphocytes are found often about the lymphatic vessels and the veins or arteries of the muscularis. The mucosa may become entirely destroyed, or, on the other hand, only localized areas undergo necrosis. The lumen becomes filled with mucosal cellular débris and by cellular elements from the submucosa. Usually few polymorphonuclear neutrophils are seen in such an histologic picture after the initial inflammatory process has occurred. The crypts of Lieberkühn undergo varying degrees of destruction and are thus unable to regenerate the mucosa needed to keep the lumen patent. The crypts that escaped injury are insufficient to perform this task and soon disappear. The lymph follicles reveal varying amounts of disintegration. Their "reaction-centers" promptly disappear. The architecture of the follicles is often markedly distorted by efforts towards restoration of function. Marked endothelial hyperplasia of the lymphatic sinusoids is commonly observed. Lymphocytes are mobilized *in situ* in the appendiceal

submucosa. Marked phagocytosis may be seen in the submucosa and particularly in the interfollicular portion.

The small lymphocytes, histocytes and monocytes are the chief actors in the process of phagocytosis. Often endothelial proliferation of the submucosal capillary network may be seen, giving rise to many free endothelial cells. Often considerable numbers of adult erythrocytes are observed in the midst of this process. Occasionally small embolic abscesses and thrombosed blood vessels are found in the submucosa. Frequently, a large fecolith fills and dilates the lumen causing erosions and irreparable damage to the mucosa. These breaks in the protective lining of the mucosa allow the entrance of bacteria into the submucosa, thus initiating inflammation there. Probably the fibrosing action of Escherichia coli and of Streptococcus fecalis, as pointed out by Adami, may be important factors in the production of new connective tissue in the submucosa. Some of my findings agree with those of Steinberg described by the term of "degenerative appendicosis." During this stage in obliteration the mucosa and portions of the submucosa demonstrate their necrosis by failing to stain or to reveal cellular details when tissue stains are employed. Following phagocytosis, a lacework of reticular connective tissue alone remains of those portions of the mucosa and submucosa which were destroyed. The areas between the fibrils of this mesh sooner or later become filled with adipose tissue. The adipose tissue is observed to make its first appearance in the immediate perivascular areas of the remaining patent arteries in the submucosa. This tissue then spreads to other portions of the submucosa. Some evidence also points to the partial origin of adipose tissue from interfollicular endothelium and lymphoid structures.

Careful studies show that the new reticulum formation originates in the interfollicular area of the submucosa from vascular and lymphoid sinusoidal endothelium as well as from remaining lymphocytes and fibrocytes. Maximow,[13] Bloom,[4] and Palmer and Higgins[14] all agree that fibroblasts may arise from lymphocytes. Mallory[10] has clearly shown that endothelium also serves as a source for the production of reticulum. If any lymphoid structures remain in the obliterated portion after resolution of the inflammation, the subsequent formation of new hyaline collagenous connective tissue is correspondingly increased. Van Gieson stains clearly show that the newest connective tissue originates in the area comparable to the site of the former interfollicular layer of the submucosa. The oldest hyaline connective collagenous tissue is found adjacent to the junction line with the muscularis. Here, however, the amount of hyaline collagenous connective tissue is markedly less than that found occupying the central area of the site of the former lumen. This new tissue extends in a stellate manner peripherally. No evidence was obtained from this study that will substantiate the assertion that this newly formed reticular connective tissue was derived from adult endothelium of blood vessels or from older adult hyaline collagenous connective tissue situated in the peripheral portions of the submucosa.

As time goes on, the central area of the obliterative phenomena becomes

more and more replaced by collagenous hyaline connective tissue. Staining reactions clearly continue to demonstrate that the source of this new tissue proliferation is in the central portion of the former submucosa. The amount of adipose tissue progressively diminishes, until only small localized collections may be observed about the remaining patent arteries in the peripheral portions of the former submucosa. Sometimes the entire area of the former submucosa becomes completely replaced by hyaline collagenous connective tissue. There is a progressive arteriosclerosis and endarteritis of the blood vessels. As a consequence of this condition and due to atrophy from disuse, the muscularis undergoes considerable atrophy. Usually Meissner's plexuses are completely destroyed during the process of repair following inflammation or during obliteration. The plexuses of Auerbach often are seen to undergo slight but definite degrees of hyperplasia in obliterated specimens. However, I believe that "carcinoid tumors" of the appendix are probably usually derived from submucosal epithelioneurogenic elements.

The histologic picture sketched above may vary in marked degree from large cellular collections, extensive mucosal destruction, and complete replacement of the former submucosa with new hyaline collagenous connective tissue, to an histologic picture in which one or all of these cellular changes may be present to only a slight degree.

In specimens showing a definite junction line between the obliterated and patent portions of the lumen, similar cellular changes of much less extent and severity are usually to be seen. It is only in the limited area of the juncture that any evidence of the presence of inflammatory processes may be detected. In as much as the same cellular processes are responsible for this type of progressive obliteration of the lumen as were just described above, I shall not repeat them. A progressive diminishment in the blood supply to the distal portion of the appendix may be an important factor in its causation, aided by a low grade inflammation.

From the foregoing descriptions, it is apparent that inflammation is largely responsible for such an histologic picture, but it must be remembered that involution also plays a contributing rôle.

Many factors play important rôles in the production of obliteration of the appendiceal lumen: the *first factor* is that the vermiform appendix in man represents a vestigial structure whose functions in human physiology are little known and are apparently of slight consequence. As various stages in mammalian development are ascended, the appendix becomes more and more a vestigial structure with a progressively diminished lumen which has an increasing tendency towards stenosis.

The *second factor* is that the blood supply to the appendix is of the terminal type, meaning that the distal two-thirds is solely supplied by non-anastomosing end-branches of the appendiceal artery. The appendix has no other appreciable source of vascular supply aside from the appendicular artery. It is obvious from such a vascular arrangement that the tip of the appendix may receive a much lessened blood supply than other portions

nearer to the cecum. Furthermore, any process which causes a narrowing and diminishment in the lumen of the appendiceal artery necessitates that the tip of the appendix must obviously be the first portion which may be deprived of adequate nourishment. It is thus apparent why the tip of the appendix is the most common situation where lumen obliteration has its inception and why this stenosing process later extends progressively proximally towards the base of the appendix. In this study several specimens were obtained from individuals who died before the age of 25 from so called "malignant hypertension." All of these appendices showed rather advanced complete lumen obliteration.

The *third factor* of this discussion is that all humans after having reached maturity, at about the age of 25, begin a steady but slow retrogressive involution of all body tissues. This process occurs faster in those tissues, such as the appendix, which have no appreciable physiologic function. In individuals over the age of 25 we are in the presence of tissues already slowly becoming senescent.

The *fourth factor* is that capillary beds of all parenchymatous organs, as the brain, kidneys, spleen, *etc.,* undergo a progressive and definite obliteration after physical maturity is reached during the third decade. There can be little doubt that this process occurs to a considerable degree in the appendix.

The *fifth factor*, having a bearing upon this problem, is the recognized observation that the human appendix is notoriously unable to cope with even a mild infection, which occurring elsewhere in the body would be of little consequence. However, in the appendix, gangrene and perforation frequently result. This serves as additional evidence of the inadequacy of the terminal type of its vascular supply. The actual volume of blood reaching the appendix tip must be considerably less than that supplying the base, and that is probably why gangrene and perforation usually occur at the tip in acute appendicitis.

The *sixth factor* in this consideration is the peculiar tendency of adipose tissue to collect in the appendiceal submucosa. The adult appendix is a vestigial structure, possessing poor peristalsis, having a poor inadequate blood supply and a natural tendency towards involution. The fat of the meso-appendix apparently migrates in along the course of the perforating blood vessels as they ramify from the meso-appendix to the submucosa. This occurs in the appendix normally to the exclusion of other portions of the gastro-intestinal tract due to the factors mentioned above. Adipose tissue is probably a visible expression of the static regressive condition of the vermiform appendix.

The *seventh factor*, that obliteration of the appendix is found more frequently in older individuals, is more apparent than real. Probably a large number of these specimens were obliterated by an inflammatory process early in life. Obliteration apparently occurs predominantly in "civilized" races. Surgically removed specimens reveal a greater percentage of lumen obliteration than do those obtained at postmortem, both groups being derived from

individuals varying in age from 11 to 29. This fact substantiates the contention that inflammation plays an important rôle in the production of lumen atresia. The facts that many individuals more than 60 years old of age still possess patent appendices, and also that the percentage of lumen obliteration between the fourth and eighth decades of life show little progressive increase with age, strongly argues against the contention that obliteration is mainly dependent upon senescent involutionary factors alone, or chiefly, for its causation. The finding of specimens of obliteration which begin in portions of the lumen distant from the tip and often in several widely separated locations at once, support the inflammatory origin of such changes in the lumen. The presence of "carcinoid tumors" in obliterated portions of the lumen may argue that such tumors had their origin from inflammatory stimulated epithelial or argentaffine cells in or near the crypts of Lieberkühn or from portions of Meissner's plexuses which had remained behind as isolated nests of cells in the inflammatory produced lumen obliteration.

The *eighth factor* is that the histologic appearance of the obliterated appendiceal lumen at the time of the occlusion strongly argues its inflammatory origin.

The *ninth factor* is that all structures containing an excess of lymphoid tissue normally have a tendency to undergo involution after maturity has been reached. The appendix certainly has an apparent excess of lymphoid tissue.

These nine factors are the chief contributing agents to this complicated consideration of the production of obliteration of the appendiceal lumen. The data from this study present evidence that involution is usually either a predisposing or a terminal process in appendiceal obliteration; but that inflammation is the main causative factor which actually and initially institutes the lumen stenosis.

CONCLUSIONS

Obliteration of the appendiceal lumen occurs largely as the result of a previous inflammation which destroys the mucosa and portions of the submucosa. Physiologic involution is a contributing factor in appendiceal lumen stenosis. Data on these two facts have been presented. Many appendices remain entirely patent during the life of the individual even though he live until the ninth decade. The source of the new hyaline connective tissue which obliterates the former lumen is partially derived from the lymphoid-endothelial tissues present in the interfollicular layer of the submucosa. This fact has not been sufficiently stressed in the past.

Normal and abnormal collections of submucosal adipose tissue are in part derived from lymphoid-endothelial elements. However, most of this adipose tissue probably reaches the submucosa by a simple process of migration in from the meso-appendix along the course of the perforating blood vessels. The amount of fat in the submucosa of the appendix bears slight relationship to the state of nourishment of the individual.

"Reaction centers" in lymph follicles remain in patent functioning ap-

pendices during the life of the individual, even though he live far beyond his expected span of "three score years and ten." These "centers" represent visible expressions of the active physiologic activities on the part of the lymph follicle towards inflammation.

Obliteration may begin in any portion of the appendiceal lumen and extend either towards the tip or towards the base. Blind cavities may be left by this process which may become mucoceles, cysts, or empyemas depending upon the circumstances in each case. Usually obliteration begins at the tip and extends proximally towards the base. The mechanism of the two chief methods by which the appendiceal lumen is obliterated has been carefully described. The histologic picture of beginning obliteration was delineated in detail.

"Carcinoid tumors" of the appendix usually occur in obliterated portions of the lumen.

Most appendices are anterior in position. More retrocecal specimens are obliterated and hence in the past they were probably originally subjected to more frequent inflammation than the present free anterior appendices. The male appendices averaged 0.68 cm. more in length than did the female specimens. Apparently, shorter appendices become more easily inflamed and consequently obliterate more frequently than do specimens averaging more than 6 cm. in length.

Inflammation is the chief initiating agent of appendiceal obliteration. This is especially true in specimens derived from individuals under the age of 35. Above this age involution may partially initiate or complete the final stages of the obliterative process. The reason why the appendix is the only portion of the adult gastro-intestinal tract to undergo obliteration may be explained upon the basis of inflammation, senescent involutionary tissues, inadequate terminal blood supply, poor peristalsis and inability to overcome infections that elsewhere in the intestine are of trivial consequence.

The appendix possesses an apparent increase of lymphoid tissue over that of the rest of the gastro-intestinal tract, which is explainable by the embryologic fact that the appendix represents a considerable portion of the adult cecum which failed to assume its normal dilated state. The lymphoid tissue in the appendix is merely a condensation of what was originally intended to serve a much greater surface area.

I have been unable to find proof from this study that the sympathetic nervous plexuses of the appendiceal wall or neuromata formation from argentaffine cells play any appreciable rôle in the formation of new connective tissue present in obliterating appendices. Mallory's views that endothelium and Maximow's contentions that lymphocytes possess polyblastic abilities to produce new reticular connective tissue under the stimulus of inflammation can be fully substantiated in the case of obliteration of the appendiceal lumen. These two cellular elements are important factors in the production of obliteration.

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POSTANGINAL SEPSIS

CAUSED BY A NEWLY DESCRIBED HEMOPHYLIC ANAEROBIC BACILLUS

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MANY cases of postanginal jugular thrombophlebitis with sepsis have been reported during the past decade, principally by German authors. The historic review of this condition has been repeatedly given in previous communications of various authors. This paper is presented to describe a carefully studied case of postanginal sepsis caused by a previously undescribed etiologic agent.

CASE REPORT

Case 11338.—T. McC., a colored widow, aged 24, was admitted September 8, 1933, to the Otolaryngologic Service of Dr. Samuel Iglauer at the Cincinnati General Hospital. The patient complained of unilateral (right) sore throat of five days' duration associated with dysphagia, inability to open the mouth, generalized aching of the muscles, headaches and an indefinite history of nightly chills since the onset of the sore throat.

Physical examination revealed a well developed, well nourished adult colored female, who appeared moderately ill, uncomfortable, and unable to open her mouth widely. Examination was essentially negative except for the local findings. The heart and lungs were not remarkable with the exception of the rapid pulse and respiratory rate.

Temperature, 104° F.; pulse, 112; respirations, 28. Blood pressure, 130/90. A large peritonsillar abscess was found on the right side. This was incised and a large amount of thick grayish-yellow pus with a foul odor was evacuated. Culture was negative. White blood cells, 18,000. The abscess was reopened on the following day.

The course of the illness was progressively downhill, the temperature remaining high and the patient becoming very toxic. On September 16, a swelling beneath angle of right mandible, suspected of being a parapharyngeal abscess, was operated upon by Dr. Samuel Iglauer. The internal jugular vein was filled with thick, creamy, putrid pus above a large thrombus at the level of the omohyoid muscle. The internal jugular vein was ligated below the thrombus, incised longitudinally, and drained with iodoform gauze. Culture was negative. However, on smearing and staining some of this pus, many intracellular gram-negative bacilli were observed. No coccus forms were seen. Culture under special conditions yielded an anaerobic, hemophilic, hemolytic, gram-negative bacillus in pure culture.

On the night of operation the patient experienced her first chill since her admission; it was severe and lasted 25 minutes. The temperature rose to 106.2° F.; pulse, 140; respirations, 30. She coughed frequently and complained of pain in the upper left abdominal quadrant.

Postoperatively the patient had many severe chills occurring irregularly from twice daily to once every other day. A soft systolic mitral murmur, which, in one week's

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* The greater part of this work was carried on in the Department of Bacteriology of the University of Cincinnati and Cincinnati General Hospital, and completed at the Henry Ford Hospital, Detroit, Mich.

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time, became loud, harsh and transmitted to the left axilla, was heard for the first time. Anaerobic blood cultures taken just after the onset of three of the chills yielded upon six days' incubation, the hemophilic anaerobe in pure culture. A blood culture taken with reference to a chill was negative.

The patient also developed abscesses of the left and right shoulder joints and left and right hip joints in the five-week period after operation. Upon incision of each of these, the pus yielded on cultivation the same anaerobe. Smears of the pus showed the organism as an intracellular bacillus. Terminally, just before death, blood cultures showed the anaerobic bacillus and a hemolytic streptococcus.

In spite of repeated blood transfusions, the patient's red blood cells and hemoglobin rapidly fell to 1,500,000 and 28 per cent, respectively. She expired October 24.

The autopsy was performed in the Pathologic Department of the Cincinnati General Hospital by Dr. Ralph Fuller.

Anatomic Diagnosis: "Visceral evidence of septicemia; cerebral venous septic thrombosis; cerebral congestion; possible early meningitis; multiple lung abscesses; perisplenic abscess; multiple pyarthrosis with surgical drainage; vegetative mitral endocarditis, possibly rheumatic; toxic myocardosis, nephrosis, and hepatosis; fatty infiltration of the liver, active vaginitis, endocervicitis, endometritis; chronic salpingitis; focal pleural fibrosis and slight aortic arteriosclerosis."

Microscopic Diagnosis: "Organizing cerebral venous sinus thrombosis and multiple pulmonary abscesses (active, atypical, pleomorphic, granulomatous reaction with numerous phagocytic macrophages and plasma cells); reticulo-endothelial hyperplasia in the spleen and lymph nodes; hemosiderosis and focal necrosis in the spleen; small verrucous scar on the mitral valve; myocardosis, edema and focal fibrosis in the myocardium; hepatosis, slight chronic pericholangeitis; chronic passive congestion with central atrophy and fatty infiltration of the liver; low grade chronic salpingitis and vaginitis, active chronic cystitis; slight aortic arteriosclerosis."

Pyarthrosis was present in both shoulder and both hip joints, and large abscesses had extended into the soft tissues immediately adjacent to these joints. The anterior cusp of the mitral valve presented a small focal area of scar-like thickening in its midportion near the line of closure. Firmly adherent to the atrial endothelial surface of this focal valvular thickening was a small cluster of minute, dense, pale, verrucous vegetations. These little polyp-like projections were so firmly adherent to the endothelium that they could not be torn away with forceps. It is interesting to note that clinical evidence of organic, mitral insufficiency developed during the course of the patient's illness and increased rapidly.

In the lungs numerous, scattered, subpleural, small abscesses were found in the interlobar spaces between the right middle and lower lobes.

Multiple fibrous adhesions bound the spleen to the surface of the diaphragm and enclosed a small abscess cavity between the spleen and diaphragm.

The right lateral, sigmoid, and petrosal sinuses were found dilated and occluded by friable, pale-yellow thrombus.

The organism obtained from this case was a pleomorphic, gram-negative, hemophilic, hemolytic, obligate anaerobe. It was cultured with considerable difficulty, growth appearing in five to seven days only on media containing blood and only under strict anaerobic conditions. Best growth was obtained on fresh blood agar slants containing 0.2–.3 per cent dextrose and 1.0 per cent agar. The growth is heaviest in the water of syneresis. Growth will occur on chocolate agar slant to a lesser degree; none was obtained on gelatin, soft egg, brain broth, Loeffler's or dextrose-ascites-agar unless a few cubic centimeters of sterile fresh blood were added. The strict hemophilic requirement has remained unchanged throughout one and one-half years' artificial cultivation.

DESCRIPTION AND PROPERTIES OF THE ORGANISM RECOVERED

Morphology: When first isolated the organisms showed a tendency toward thread formation. On further cultivation they lost this tendency and appeared as very pleomorphic, minute bacilli with rounded ends. No spore formation was observed.
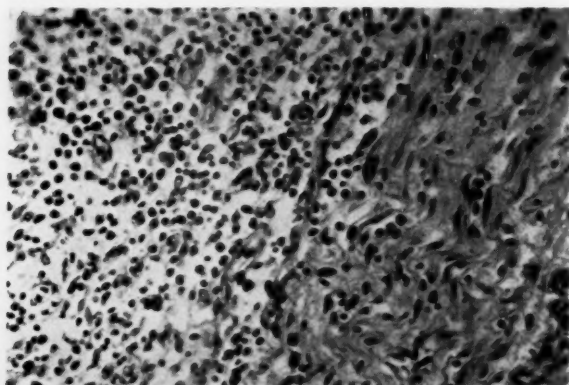

Fig. 1.—Section of wall of abscess in pectoral muscle showing atypical pleomorphic granulomatous cellular reaction with numerous phagocytic macrophages and plasma cells.
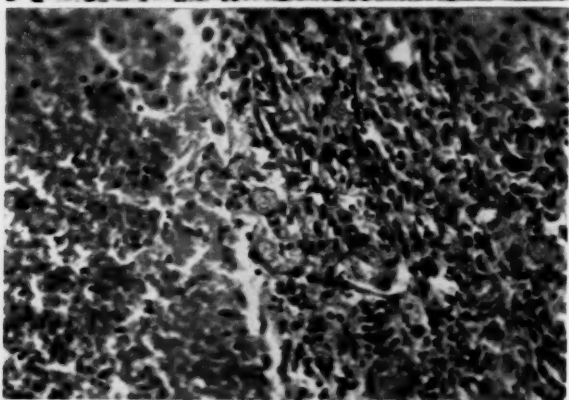
Fig. 2.—Section of lung abscess showing necrosis and abscess wall with granulomatous pleomorphic cellular reaction. Note the great number of phagocytic macrophages and plasma cells.
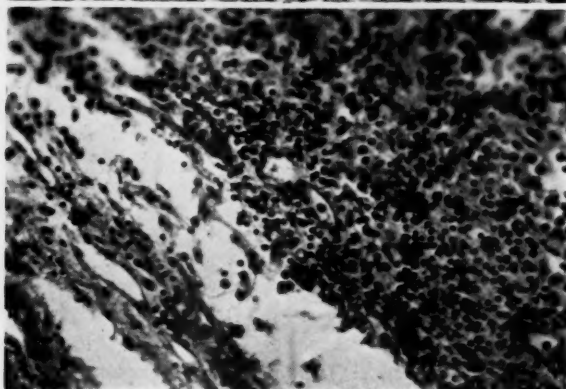
Fig. 3.—Section of cerebral venous thrombosis showing the same type of pleomorphic granulomatous cellular reaction.

Staining: The bacillus is stained with great difficulty by the usual anilin dyes. When stained by Gram's method, it appears as a faintly staining, small, gram-negative rod. Best results were obtained by five minute staining with steaming dilute (1:20) carbol fuchsin. When stained with Giemsa's stain or dilute carbol-fuchsin, the bacillus shows bipolar staining, especially after recent passage through a susceptible animal.

Motility: Nonmotile.

Growth: Strictly anaerobic. No growth obtained aerobically or under partial tension even after one and one-half years of artificial subcultivation. Good growth obtained with pyrogallic acid and Rockwell's solution. After inoculation of blood agar slants, no growth was visible with the naked eye until the fourth or fifth day when numerous, flat, minute, discrete, translucent colonies are first visible on the surface of the slant. Growth of the organism in the water of syneresis is manifested by a fine, flaky suspension. A very fetid odor was produced when this bacillus was cultured artificially, similar to that found in the fetid abscesses in the case presented.

Glucose, maltose, saccharose, lactose, mannite, xylose and levulose are fermented by the organism, with production of acid but no gas. Dulcite, erythrite, inulin and galactose are fermented with the formation of acid and gas.

Proteolysis: No liquefaction of gelatin. No proteolysis of coagulated serum.

Milk: No growth in absence of fresh blood.

Nitrate Reduction: Nitrates are reduced to nitrites.

Indole Formation: No indole formed on tryptophan broth.

Animal Pathogenicity: Pathogenic for rabbits but nonpathogenic for guinea-pigs and mice. Eight guinea-pigs were injected subcutaneously or intra-abdominally with 2 to 4 minims of a saline suspension of seven to ten day old culture. These animals were all living and apparently well six weeks later. They were then autopsied. No pathologic findings were noted and the organism was not recovered from the heart blood in any case. Also, ten young mature mice were injected subcutaneously or intra-abdominally with 1 to 4 minims of a saline suspension of the organism. These animals were living and well six weeks later. Autopsy revealed no significant pathology. The organisms were not recovered in any case. Seven rabbits were injected intravenously with 2 to 5 minims of a saline suspension of the organism. All these animals died within 10 to 17 days. In the autopsied animals multiple abscesses of the lung, liver, and spleen were found in six instances, peritonitis centering about the liver in three instances, empyema and polypyarthrosis each in two instances.

It is interesting to note that this organism apparently has a specificity for endothelial tissue as manifest by nature and location of the lesions produced both in the patient and the rabbit.

To prove that this bacillus was the etiologic agent in this case, the following facts are advanced:

(1) The organism was obtained in pure culture from the thrombophlebitis of the internal jugular vein and from each metastatic abscess at the time of their initial incision.

(2) The organism was seen in smears prepared from pus of each metastatic abscess as a very small, gram-negative rod.

(3) The bacillus was grown in pure culture from the blood stream on three occasions during the progress of the disease. Terminally, four days before death and at autopsy, a hemolytic Streptococcus was also found, but not before.

(4) None of the smears examined from abscesses showed Streptococci at the time of their initial incision.

(5) The patient gave repeatedly positive intradermal skin reactions to this bacillus.

(6) In the second month of her illness, the patient's serum agglutinated suspensions of this organism in dilutions up to 1,800.

(7) Artificial cultivation of this anaerobe produces the same fetid odor noted in the various metastatic lesions.

(8) The unusual microscopic picture of atypical, pleomorphic, granulomatous tissue reaction with numerous phagocytic macrophages and plasma cells is in favor of an unusual infecting organism rather than a Streptococcus.

During the past 18 months the literature has been reviewed in an effort to find a description of this bacillus. No mention of an anaerobic, hemophilic, hemolytic, gram-negative bacillus was found. Many anaerobes have been described chiefly by German writers as etiologic agents in cases of postanginal sepsis and other thrombophlebitic processes, and when present give a definitely poorer prognosis. This has been shown especially by Eugene Frankel[7] and Kissling.[15, 16, 17] Detailed studies of morphology, cultural characteristics, and pathogenicity are available for few of these organisms. In most instances it is simply stated a gram-negative bacillus was found either in pure culture or in association with a Streptococcus. Anaerobic Streptococci have been frequently found in the blood streams of such cases. Schottmuller[4, 5] has described a gram-negative anaerobic bacillus found in association with the Streptococcus putrificus in cases of puerperal sepsis and in embolic putrid lung abscesses. He has named this bacillus, therefore, the Bacillus symbiophiles. Kissling has described 14 causes of postanginal sepsis in which he has obtained a gram-negative bacillus from the blood stream in pure culture. This organism he believes is identical with Schottmuller's Bacillus symbiophiles.

The bacillus obtained from the case here presented is strictly hemophilic, definitely hemolytic, and pathogenic for rabbits, while Schottmuller's Bacillus symbiophiles is not hemophilic, is not hemolytic, and is nonpathogenic for rabbits, guinea-pigs, or mice (Nedelmann[20]). Complete bacteriologic studies of Bacillus symbiophiles have been hindered by the great difficulty of separating it from the Streptococcus putrificus.

Eugene Frankel (1925) presented ten cases of postanginal sepsis, first pointing out the importance of anaerobic bacteria in the etiology of thrombophlebitis. He also stated that the putrid character of the metastatic abscesses bespeaks the anaerobic nature of the etiologic agent. He reported a gram-negative, anaerobic bacillus found in pure culture in one case and in association with various anaerobic Streptococci in others. No detailed bacteriologic studies of these bacilli were presented.

H. Lenhartz reported five cases of postanginal sepsis in which he found gram-negative anaerobic bacilli in the blood stream in three of the cases, in pure culture in one instance, and in association with anaerobic Streptococci in two cases. Bacteriologic studies were not given.

Wirth has described a gram-negative anaerobic bacillus as an unusually virulent cast of acute, middle ear disease. This is probably identical with that described by Schottmuller and Kissling.

E. Nedelmann, in 1928, reported a case of pyelophlebitis and sepsis complicating appendicitis, in which he demonstrated an anaerobic, gram-negative bacillus in the blood stream in pure culture. After studying this organism he concluded it was identical with the Bacillus symbiophiles of Schottmuller.

In 1931, H. E. Mansell[23] described a case of suppurative arthritis caused by a hemophilic bacillus in a nine months old infant. This organism was found to be gram-negative, very difficult to grow, and nonpathologenic for guinea-pigs. No further bacteriologic findings were given; no statement was made as to the oxygen requirements of this bacillus.

Victor K. Russ described a slowly growing, anaerobic, small, easily stained, gram-negative bacillus which he obtained from a peri-anal abscess in association with a short-chain Streptococcus. He was impressed with the similarity of this organism and the influenza bacillus both morphologically and culturally. However, the bacillus was not strictly anaerobic, and could be cultured on dextrose nutrient agar in the absence of blood. No mention was made of any hemolytic properties. Unfortunately, he was unable to culture the Streptococcus artificially which he had observed in the stained smears. Doctor Russ injected only mice with saline suspensions of this organism and was unable to demonstrate any pathogenicity. He concluded the bacillus was a saphrophyte in an abscess caused by the short-chain Streptococcus.

F. W. Hartman and E. Jackson,[21] in 1930, reported a gram-negative, essentially hemophilic bacillus from a case of fatal meningitis. This organism grew aerobically, however, and on dextrose ascitic agar in the absence of blood. It was not hemolytic, and it was pathogenic for guinea-pigs, rabbits, monkeys and dogs.

Numerous typical cases of thrombophlebitis with sepsis and metastatic abscesses have been described in which all attempts to obtain positive cultures from the blood or pus were either entirely unsuccessful, or yielded terminally just before death a Streptococcus or Staphylococcus. Kissling reports four such cases in which anaerobic bacteria were suspected but never demonstrated. It is suggested that those cases may be caused by an anaerobe similar to the one here described which is relatively difficult to culture, and that many of these cases would yield positive cultures with better methods of culture. It is interesting to note here the explanation given by Libman and Celler[22] for the negative blood cultures they obtained in cases of sinus thrombosis of infectious origin:

"We are inclined to believe that early there may be no bacteremia, that the bacteria may then be found perhaps in increasing numbers, and that it is possible for the bacteria to decrease in number, even to disappear before there has been any operative interference.

"It is also possible that in certain cases there is below the infected clot an obturating, noninfected clot which prevents the bacteria from entering the circulation. We can also imagine the possibility of there being an infected clot which completely closes the vessel. Another possible explanation is that in the course of the infection the blood may acquire a higher bac-

teriacidal power." No consideration of the possibility of the etiologic agent being one which lends itself to artificial cultivation with considerable difficulty is made.

It is remarkable how many cases of postanginal thrombophlebitis with sepsis have been described in association with gram-negative, anaerobic bacilli, and unfortunate how few of these bacilli have been reported with careful bacteriologic studies on their morphology, cultural characteristics, and pathogenicity.

In this paper a gram-negative, pleomorphic, hemophilic, hemolytic bacillus has been studied and described as the primary etiologic agent in a typical case of postanginal sepsis. This case is also presented with clinical and pathologic studies. This organism, as far as can be ascertained, after a careful search through the literature, is described for the first time in this paper.

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ASPIRATION OF BREAST CYSTS*

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A GENERATION ago two members of the New York Surgical Society contributed papers dealing with cystic conditions of the breast with special reference to treatment. William T. Bull[1] reported 39 cases of single cystic tumors and eight cases of general cystic disease which he treated mainly but not exclusively by aspiration. He said, "We have little evidence that the condition degenerates into cancer." Somewhat later Dr. Robert Abbe[2] reported 41 cases of cystic disease of the breast seen by him in eight years. Three-fourths were single cysts and one-fourth were multiple. He says, "There is probably no experience of the surgeon that yields him greater pleasure than to see the profound gratitude of patients who have come to him expecting a mammary amputation, to be told when the mammary cyst is aspirated that they are well." He followed his patients to the date of his publication and found none of them had developed cancer.

We have aspirated fully 50 cysts in the last 20 years. In several cases two or three aspirations have been performed at varying intervals and in one case there were at least four aspirations. In several cases two cysts have been aspirated at one sitting. Aspiration has never been adopted as an exclusive method of treating breast cysts, as is shown by the fact that during the same time 160 cases of benign breast conditions have been submitted to operations such as enucleations, partial or complete mastectomies.

So far as is known, no favorable comment was elicited by the papers of Bull and Abbe but they did bring forth some unfavorable criticism. In my series of cases there is no single instance in which I have gotten myself or patient into trouble as a result of submitting her to aspiration of breast cysts.

The aspiration method has been reserved for breast cysts in which one could be quite sure either from consideration of the history or digital examination that the mass was a cyst and to my knowledge an aspirating needle has never been introduced into a breast carcinoma. Perhaps the knowledge that the procedure is not looked upon favorably by surgeons has made me particularly cautious. After the cyst has been aspirated considerable time is always given to a discussion with the patient of the treatment of breast cysts. She is told that the method is not usually favored, that the cyst may refill and that the question of the advisability of operation has not been definitely settled.

At the conclusion of an aspiration one should be guided by the four following considerations:

* Read before the New York Surgical Society, October 23, 1935.

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(1) If the content of the cyst is bloody, operation should be urged.

(2) If the cyst refills promptly, it will probably be wiser to resort to surgery. Very few of them do refill although other cysts may develop in the same or in the other breast. In one patient with a single cyst filling has not occurred in ten years. In another case the cyst refilled six years after an aspiration.

(3) The cyst wall is usually thin so that after complete aspiration the local area should be flat and there should be no remaining induration.

(4) The patient should be told to return if the cyst refills, and, under any circumstances, to return to the surgeon for reexamination within a month. Few will be found to have refilled and it is only by noting the point of entrance of the needle that one can identify the previous location of the cyst.

There seems a very strong prejudice on the part of surgeons against aspirating cysts. One is usually told that it is dangerous teaching. That it is would seem to be assumed from a fear that incompetent persons inexperienced in breast diagnosis and surgical treatment will be tempted to resort to this simple surgical procedure both in cases of cystic disease and also in the presence of lumps which they think may be cystic. If the precautions above mentioned are followed the dangers of the procedure will be very slight. None of the surgeons with whom I have discussed the subject admit that they ever resort to aspiration. On the other hand, Doctor Abbe states that it becomes the duty of every surgeon to test the nature of each doubtful hard tumor by an aspirating needle. With this I should not agree, preferring to treat every doubtful hard tumor by surgery.

The immediate relief that aspiration of a cyst gives to the frightened patient who has discovered a breast tumor is almost beyond belief. There are few occasions in a surgeon's career when he can give such immediate relief to mental suffering, establish a diagnosis and usually cure the patient.

It is, of course, this fear of cancer that keeps surgeons from aspirating cysts but it is often difficult to decide upon a method intermediate between aspiration of a cyst (or one excision to establish a diagnosis) and the removal of both breasts. A single partial mastectomy establishes a diagnosis of the condition of the portion of breast removed but does not prevent the development of cancer in the portion of breast retained, nor does it guarantee that carcinoma may not be present in other portions of that breast or in the opposite one.

Cheatle's[3] statement that 20 per cent of cancers of the breast are associated with cystic disease is much quoted but one should continue by quoting his next sentence, namely that, "The problem of the percentage of cystopherous, desquamative hyperplasia that end in carcinoma is much more difficult of calculation. The process begins as a desquamative epithelial hyperplasia which ends in the formation of cysts and occupies the decade of the late twenties and early thirty years of life. The desquamative process of the epithelium may not end in the formation of cysts but may pass into a state of epithelial neoplasia that is benign in character." Later on he says, "As a

general rule cysts containing clear fluid are not associated with malignant disease. Suspicion should at once be aroused if the contents of the cyst are in the slightest degree cloudy or contain blood or if the cyst wall is dense and bulky. An apparently single large cyst rarely contains carcinoma. Its epithelial lining is so degenerated that it is incapable of responding to the stimulus that produces neoplasia." Cheatle's statement that cancers of the breast show microscopic evidence of cystic disease may be correct but it is my experience that cancers of the breast are not associated with *clinically* recognizable chronic mastitis, that is, a nodular or cystic breast, in anything like 20 per cent of cases. Cancer usually appears if seen early as a single, fairly discreet nodule, whereas cystic disease is a more widespread condition. It may chiefly affect one lobule but very often involves all of one or both breasts.

Crile[4] has stated that "if the condition—that is, cyst formation—is present in both breasts, malignant changes almost never develop." Ewing[5] states that in 50 per cent of breasts removed for cystic disease which he has examined, precancerous changes or "miniature carcinomas" were present. If this interpretation of his microscopic pictures is correct, it seems remarkable that one can treat a considerable series of breast cysts by aspiration, observe them for a considerable period of years and not have a number of them return with carcinoma.

Rodman[6] has studied the changes in breast tissues and says, "The amount of involution and evolution which a breast undergoes during its active life is great, no other organ being given to more epithelial unrest." Inasmuch as pathologists vary in their statements of the percentages of cancers of the breast in which hyperplastic disease is an accompaniment and give figures as far apart as 15 and 83 per cent, it may be that they are considering as abnormal hyperplasia some conditions which others would consider within the normal range of changes accompanying the menstrual cycle or early pregnancy.

Clinicians have been attempting to solve the problem from a different angle, employing a follow up of patients who have been submitted to partial or complete mastectomies for what has been considered chronic or cystic mastitis. Both Rodman[6] and Pickhardt[7] have changed their view considerably as a result of follow up of their clinical material. Pickhardt approached the subject with a preconception that the disease was of a precancerous nature. In studying the material from the Lenox Hill Hospital embracing 90 cases of cystic mastitis on which a follow up could be made, he says, "The clinical result as shown by a follow up of this series, even where only a local excision had been done, are so excellent and so remarkably free from cancer that the speaker has been convinced against his original inclination and must now feel that chronic cystic mastitis is a benign condition. If it is precancerous it shows that removal in that stage is sufficient to eradicate the cells which tend toward malignancy." The work of such clinicians as Campbell,[8] Kilgore,[9] Klingenstein,[10] Pickhardt[11] and Rodman[6] all tend in the same direction. Adair[12] is impressed with the importance of conditions

which produce stasis in the breast as causing first hyperplasia and then carcinoma. His evidence is based on the study of 200 consecutive cases of cancer of the breast with relation to pregnancies, miscarriage, sore nipple, etc., and has brought him to the conclusion that stagnation is of prime importance relative to the subsequent development of cancer. The frequency of these factors of stasis was very much greater in the cancer cases than in the 100 patients without cancer whom he used as controls.

Without referring to any one individual it may be said that the tendency of the past ten years based chiefly upon the clinical aspects of chronic mastitis has been to minimize the relation of carcinoma to cystic disease, and yet no paper which I have seen which considers the subject of treatment mentions aspiration of cysts, even to condemn it.

It is rather frequently stated, though on what authority is uncertain, that about 2 per cent of women of the cancer age will develop cancer of the breast. This about corresponds with my personal experience. One patient only, with cystic disease, has developed cancer. This patient was first seen with a cyst in the upper, outer quadrant of the left breast. It was aspirated of nearly clear fluid. One year later she developed a very small, quite superficial carcinoma about two inches from the location of the cyst. She was submitted to radical mastectomy and it is interesting to note that the cyst was still present but empty with its walls collapsed. There was no carcinoma reported as being present in the cyst. One cannot think that a partial mastectomy would have prevented the occurrence of the cancer.

Another case of cystic mastitis seems worthy of record. The patient, Mrs. G., was operated on three times at St. Luke's Hospital and on each occasion a segment of breast was removed. Each contained a cyst and each time the pathologic report was chronic mastitis. She later presented herself with a swelling obviously a cyst. She expected another operation but was relieved by having the cyst aspirated. Six months later she returned with a cyst in the other breast with reddened skin over its surface. This was also aspirated and there has been no further recurrence in a year. She might have been cured permanently on any one of these five occasions by amputation of both breasts or one might have added two more partial mastectomies, making five operations for a condition which is usually benign, and which had been proven so in her case. Anything less than bilateral mastectomy would not have prevented the recurrence of cysts nor the possibility of carcinoma. Of course there is no demonstration that she may not at some future time develop carcinoma. As she has just passed the menopause it seems quite likely that cysts will stop developing. However, it seems quite unlikely that many surgeons would have suggested bilateral mastectomy in the course of this patient's disease.

We practice surgery first to prolong life, second to restore or increase efficiency, and third, to add to the sum of human happiness. With the latter purpose in mind we aim to relieve mental suffering no less than physical

suffering and it requires only one experience with the aspiration of a breast cyst to assure one's self that the relief of mental suffering is profound.

CONCLUSIONS

Aspiration of breast cysts is not recommended as an exclusive method of treating them. It will often be considered wise to do one partial mastectomy to establish a diagnosis, after which if cysts appear aspiration may be employed in the treatment of masses which are definitely cystic. It is a procedure which is reasonably safe in the hands of any one competent to do any indicated breast operation. It has both diagnostic and therapeutic value. The fact that aspiration can be resorted to as frequently as in the present series without having a conspicuous development of cancer adds some evidence in favor of the generally benign character of cystic disease of the breast.

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DISCUSSION.—DR. JOHN E. JENNINGS (Brooklyn) stated that cysts of the breast are noted as masses lying within the organ, painless as a rule, by the patient or by the physician in a routine examination. The presence of the mass is cause for examination, the dread of cancer bringing the patient sooner or later to the surgeon. Various diagnostic procedures are then undertaken: inspection and palpation of the breast for appraisal of the fixation, retraction and character of the mass itself, transillumination, roentgenologic study, and aspiration, or, as it is now termed, biopsy.

Doctor Jennings, recalling his own experience with transillumination, related that having found the available lights inadequate, he had had made in 1920 a box with a 100 watt light behind a projecting tube containing a system of lenses. This, also, was inadequate. A year or so later, a similar apparatus was made to carry a 500 watt Mazda bulb behind lenses made of crystal to diminish the heat. An iris diaphragm was inserted in the system. Although the box was covered with asbestos it was not entirely heat proof, but was effective enough to reasonably evaluate transillumination of the breast. Experience in the use of an adequate and familiar instrument enables the observer to form opinions not too often wrong. Blood will show, in hematoma, in

papillary duct growths, in the large veins, and, with experience and the iris diaphragm, acute congestion in localized areas can be recognized. The distribution of large venous channels may indicate retractible pathology rather early in a heavy breast.

It is not always possible to distinguish between a cystic and a solid growth. This will depend as much on the thickening of the tissue surrounding the cyst as on the contents of the cyst itself which may be quite opaque. Doctor Jennings had had no experience with roentgenologic studies of the breast, but was concerned with the question as to what, if any, are the dangers of needling a suspicious tumor of the breast. It is admissible that if the mass is found to be a single cyst that disappears on aspiration, with the fluid not bloodstained and the smear innocent, great comfort to both patient and surgeon results. One does this occasionally, and all goes well. But it is less certain that as a general practice aspiration of a solid tumor is without some hazard. A negative result as to malignant tissue must be purely negative, leaving doubt just where it was before. A positive return should bring prompt action. There still remains, however, the effect of aspiration in disseminating the disease. It seems probable that one carcinoma will differ from another in the degree of local transplantability as well as in the ease with which venous invasion may be brought about.

DR. WILLIAM CRAWFORD WHITE (New York) called attention to the fact that large single cysts comprise but a very small proportion of the chronic cystic mastitis cases that are seen. It is difficult to differentiate localized chronic cystic mastitis consisting of small cysts of BB shot size, from early cancer. Very often they seem to be carcinoma when they are not, and vice versa. In a large proportion of cases one necessarily has to operate. If one believes in needle puncture biopsy, one can, of course, perhaps differentiate between malignancy and cysts, but even this may not be possible. In spite of all the insistence on the finding of chronic cystic mastitis associated with carcinoma, Doctor White could not agree that it is a precancerous condition. However, in reference to Doctor Mathews' quotation to the effect that, if one saw multiple nodules, especially in both breasts, he could rest assured that it was chronic cystic mastitis, Doctor White felt great care should be exercised especially if any nodule feels hard. In the series at Roosevelt Hospital, if partial mastectomy had been harmful, more cases of carcinoma should have developed subsequently. In a series of 590 cancers of the breast only one case of chronic cystic mastitis subsequently developed carcinoma in the same breast. She had had a partial mastectomy for chronic cystic mastitis in 1923. In 1929, she developed a colloid carcinoma of the same breast. It was felt there was no relationship between the two.

DR. FRANK E. ADAIR (New York) agreed with Doctor Mathews, especially with the main implication of his paper, namely, that simple cysts can and should be treated by aspiration and not by surgical extirpation. It becomes necessary many times to excise locally the breast cyst, in order to be certain of the exact pathology. However, there are times when the diagnosis of a simple cyst is quite definite; and in such an instance the diagnosis can be confirmed and the cyst usually cured by the simplest procedure—an aspiration. A cyst when small (1 cm. in diameter or less) is difficult to diagnose because it is so tense with the intracystic fluid that palpation gives one the impression of its being a firm tumor such as a fibro-adenoma or area of localized mastitis. When the cyst becomes larger it becomes easier to diagnose because fluctuation can be elicited, the edges are sharper, and, due to expansion, it appears to be nearer the palpating fingers.

Technic.—To aspirate a cyst one should take a small sized hypodermic needle and infiltrate the skin over the dome of the cyst with a small wheal of 1 per cent novocaine. In order to keep the larger needle of the Record or Luer syringe from being gripped too tightly by the integument, it is better to make a fine stab wound just through the skin, with a narrow sharp-pointed blade. An 18 gauge needle is then inserted into the cyst. It is important that the needle should not be gripped too tightly by the skin otherwise one will not get the sensation of the needle point penetrating the cyst wall.

Most men are now agreed that carcinoma rarely occurs in a breast containing single or multiple simple cysts, and agree that the original studies of Bloodgood in which he stated that carcinoma never develops in the breast which contains a blue domed cyst, is not true. Carcinoma does, as a rarity, occur in such a breast, but in our series of simple blue domed cysts, the presence of carcinoma occurred in slightly less than 2 per cent. Bloodgood was, therefore, almost correct. My own studies show in those rare cases in which a carcinoma developed in a breast containing the blue domed cyst, that the carcinoma was not an integral part of the cyst wall, but developed in the intercystic portion of the breast. In general the breast containing the simple cyst is usually free of carcinoma.

In looking over the records of 664 breast cases coming to Doctor Adair's service at Memorial Hospital in 1934, it was found that there were 8 per cent of instances of solitary breast cysts.

In Doctor Adair's experience cysts of the breast contain fluid of several types: (1) Straw colored fluid, (2) muddy colored fluid, (3) opalescent colored fluid, (4) milky fluid or heavy, creamy fluid, (5) infected, straw colored fluid with floating flocculi, and (6) bloody fluid.

In the cases of clear, straw colored fluid and the opalescent fluid, a single aspiration cures in about 85 per cent of the cases. It always amazes me that the cyst does not promptly refill, but it usually does not. The cyst with the muddy colored fluid is not cured by simple aspiration in as high a proportion of instances. The cyst containing the flocculi is infected and always refills no matter how many times it is aspirated. This interesting cyst is the type that frequently shows skin attachment, and it is occasionally on account of this sign that it is mistaken for carcinoma. The bloody cyst should always be removed as it is cancerous in about 48 per cent of the cases. After its removal and careful study, it frequently becomes necessary to proceed with a radical mastectomy.

Solitary cysts of the breast occur in the late thirties and in the forties. In only one instance of 52 cases of last year did the solitary cyst manifest itself after 50 years of age. In other words, most of the cystic changes take place about the time of the menopause, which is a diagnostic point of importance. In the diagnosis of cysts, one must always consider the pain attribute. Pains are intensified at the time of the menses and regress after their cessation. Cysts occasionally appear with one period and completely disappear before the next menstrual phase. Cysts have a direct relationship to ovarian function. The concomitant state of cysts of the ovary and of the breast has often been noted.

In the case of multiple bilateral breast cysts, it is frequently possible to carry the patient through the period of the menopause (possibly for a year and a half) by aspirating those cysts which are most painful. It may be necessary to repeat this procedure three or four months later, but during this time the cysts gradually become smaller as the mammary tissue atrophies. This is the therapy of choice; otherwise a bilateral mastectomy would become necessary; which is most undesirable.

CHRONIC PROGRESSIVE POSTOPERATIVE GANGRENE OF THE ABDOMINAL WALL*

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GANGRENE of the abdominal wall is an unusual postoperative complication. The object of this paper is to report a case of chronic progressive gangrene of the skin and subcutaneous tissues of the abdominal wall with special reference to the bacteriology of this particular infection, its differential diagnosis and the treatment indicated for its control.

CASE REPORT

Mrs. C., aged 57, was admitted to the St. Joseph's Hospital, Tacoma, February 5, 1935, with a diagnosis of acute appendicitis. She was operated upon immediately. The appendix was retrocecal and showed beginning gangrene. The wound was closed in layers with catgut and three dermal tension sutures. The abdominal cavity was drained with a split rubber tube which was removed on the sixth day. The patient made a normal but rather slow convalescence. She was discharged from the hospital on the nineteenth day following the operation. With the exception of slight drainage from the lower angle, the wound was closed. Some redness persisted at the site of the tension sutures.

Soon after, however, the wound began to break down rapidly, and in spite of the fact that the drainage from the depths of the wound gradually ceased, there developed a progressive spreading gangrenous ulceration of the skin and subcutaneous tissues. On April 9, 17 days after the patient was discharged from the hospital, the abdominal wall presented the picture shown in Fig. 1. The wound edges had separated and extensive sloughing of the skin and subcutaneous tissues had taken place. The free edges of the gangrenous area were undermined, and surrounding the necrotic border, a zone of advance showed about 3 cm. in width, slightly raised near the gangrenous zone, cherry red in color, and gradually fading into normal tissue. *The entire area was excruciatingly sensitive.*

Free incisions, for drainage, and repeated excisions of the gangrenous slough over a period of about two months were performed. Various applications including merthiolate, hydrogen peroxide, permanganate and Dakin's solution failed to control the slowly advancing ulceration. The patient was given a blood transfusion and antistreptococcus serum without apparent benefit. Fig. 2 shows the area involved on April 29, 1935, at which time the patient was readmitted to the hospital. Her physical condition was remarkably good, considering the extent and apparent virulence of the infection. Her morale, however, was badly shaken due to the extreme sensitiveness of the abdominal wall, to pain, and to her failure to improve. The skin was so sensitive that most of the dressings were done under Evipal anesthesia.

The first bacteriologic cultures which were taken upon her readmittance to the hospital showed an enormous number of hemolytic streptococci with an occasional colony of staphylococci and B. coli. There was no growth obtained by anaerobic culture. These cultures were taken from the necrotic tissue immediately adjacent to the large ulcer, but none was taken from the unbroken zone of advance. The anaerobic cultures

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were made on brain heart infusion blood agar plates, with the use of the Spray anaerobic culture dish.[9] The bacteriologic findings led to the conclusion that we were probably dealing with a hemolytic streptococcic infection.

The clinical resemblance of this case to those described by Dr. Frank L. Meleney[1] of New York induced us to forward to him a clinical history and photograph of the lesion. He suggested that it was the same type which he had described as a progressive postoperative bacterial synergistic ulcer, and advised further bacteriologic study with especial attention to the zone of advance. Following these suggestions, further cultures were taken. From the necrotic tissue, a hemolytic staphylococcus was obtained. Cultures taken from a piece of tissue excised from the red area adjacent to the normal skin gave, by the anaerobic technic described, a growth of non-hemolytic anaerobic streptococcus in pure culture. There was no growth aerobically from this section of tissue. After two generations, this non-hemolytic anaerobic streptococcus showed slight aerobic growth on Loeffler's blood serum. This corresponds culturally to the organisms which
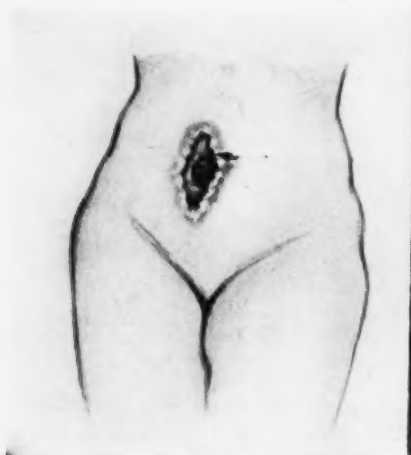
FIG. 1.—The wound began to break down on 19th day following operation. Illustration shows extent of ulceration April 9, 1935, two weeks later.

FIG. 2.—Area involved April 29. 1935. Part of slough has been cut away.

Dr. Meleney had found in similar cases and which he had predicted would be found in this case. He has designated this as "micro-aerophilic."[1, 2, 3] At this time more radical treatment was employed; not only was the sloughing tissue removed, but as far as possible all infected tissue was excised, with the scalpel, well out to the periphery of the zone of advance. Following radical excision, the wound was dressed daily with gauze saturated with a suspension of zinc peroxide in sterile water, which was covered with vaselined gauze to prevent drying.

Fig. 3 shows the abdominal wall at nearly the maximum advance. A slightly undermined area of necrosis is shown around most of the border. Fig. 4, taken about ten days later, shows the infection nearly under control. This photograph shows some new areas of skin beginning to spread from centers which have survived the necrotic process. The day this photograph was taken the last excision of tissue at the periphery was performed, and at the same time a number of Thiersch and pinch grafts were placed over the denuded area. Following the radical excision, the progress of the ulcer was definitely stopped (Fig. 5). Later, further skin grafting was done. The denuded area closed in quite rapidly until nearly covered. The patient then suffered a temporary period of retrogression, followed by gradual recovery and finally complete epithelization.

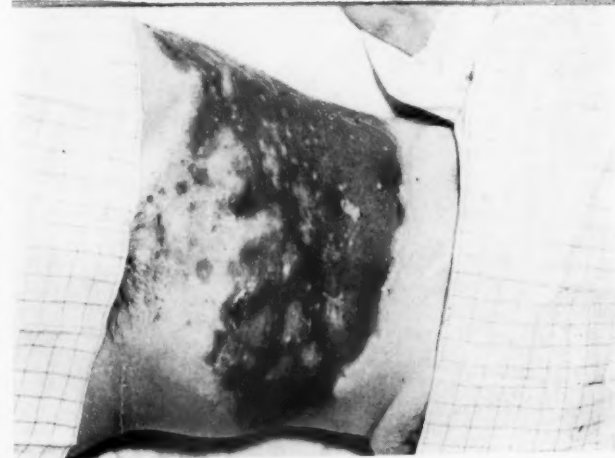Doctor Meleney, who has made an extensive clinical and bacteriologic

Fig. 3.—Abdominal wall shown at nearly maximum advance. Area of necrosis shown especially at upper border.

Fig. 4.—Infection nearly under control. Small areas of skin shown which have survived necrotic process.

Fig. 5.—Healing. Some skin grafts placed.

study of wound infections, has described several different types of superficial infectious gangrene.[3] Examples of the acute types are "gas gangrene" and "hemolytic streptococcic gangrene." Each of these conditions is caused primarily by a single bacterial species. Each has its own clinical picture, but they are alike in that both spread rapidly without a definite line of demarcation but with extreme necrosis and undermining of skin and subcutaneous tissues. Neither produces marked local pain or sensitiveness, but both produce extreme prostration and result in a high mortality, and in the case of streptococcic gangrene early positive blood cultures with metastasis are usually found.

The case described in this report, in contrast to the above mentioned types, represents one of the more chronic forms of infectious gangrene. It has a distinct and very sharply defined clinical picture. It is a spreading ulcer with a gangrenous border without undermining of normal tissue or the production of sinuses. It is characterized by slow but relentless progress, by extreme sensitiveness of the area involved and by the lack of severe systemic symptoms.

A number of cases of progressive gangrene with this clinical picture have been described in the literature.[4, 5, 6, 7, 8, 13, 14] Brewer and Meleney described two, and subsequently Meleney has described four of them,[2, 3] and has been able to culture from all of them, what he considers to be the essential organism, namely a nonhemolytic micro-aerophylic streptococcus which is found, by anaerobic methods, in pure culture in the zone of advance, but in the gangrenous area this organism is associated with a staphylococcus aureus. On the basis of these findings and animal experiments with combinations of these organisms, he has further concluded that this particular type of progressive gangrene is produced by a symbiotic or synergistic action between these two organisms. In this case, the organisms which we recovered corresponded morphologically and culturally to those described by Meleney. Furthermore, animal inoculations made by the Porro Biological Laboratories in Tacoma confirm his conclusion that this condition is produced not by a single organism but by a symbiotic or synergistic action between the two organisms— neither of which alone may be virulent.

Four guinea-pigs were given subcutaneous inoculations. The hemolytic streptococcus first obtained from the area of slough when injected alone produced an abscess which cleared up. The hemolytic staphylococcus obtained later from the area of slough when injected alone also produced a small abscess which cleared up. The nonhemolytic streptococcus from the zone of advance produced alone a small abscess. In contrast, the hemolytic staphylococcus and nonhemolytic streptococcus injected together produced a large spreading ulcer of the skin and early death of the guinea pig.

This disease must not be confused with another condition which the same author has described,[12] namely, a chronic ulceration which is nongangrenous but which is characterized by extreme undermining of the skin and formation of deep sinuses. The organism which has been found to be most

closely identified with this infection is a micro-aerophylic (facultative aerobic) hemolytic streptococcus, as contrasted with the nonhemolytic organism found in the lesion described above.

COMMENT.—This case was controlled by wide excision with the scalpel. The use of the hot cautery or radio-knife, however, is advocated as preferable to the scalpel by most clinicians who have reported cases of this type.[7, 8, 10, 11, 15] Horsley[16] states that in no instance should the scalpel be used.

It is probable that if radical excision is performed, the special dressing employed is of minor importance in controlling the infection. The zinc peroxide dressing was employed in this instance upon the suggestion of Meleney.[12] Zinc peroxide applied in suspension is believed to give off nascent oxygen over a period of several hours, and probably either by this action or by a direct peroxide action has the power of inhibiting the growth of anaerobic or micro-aerophylic organisms.

CONCLUSIONS

Experience in this case, together with a review of the literature, seems to justify the following conclusions.

This condition represents a rather rare instance of chronic infectious, superficial, progressive gangrene which belongs to a very definite clinical group and which should be recognized clinically. It is differentiated clinically from other types of superficial gangrene by its slow and relentless progression, its severe local symptoms and the absence of severe systemic symptoms.

It is characterized bacteriologically by the fact that in contrast to the other types described, it is produced, not by a single virulent germ, but by two organisms, neither of which alone may be virulent, but which in combination produce a virulent infection. It is important that the nature of this infection be recognized early, that conservative treatment be discarded, and that wide and radical excision be employed promptly.

As far as the author is aware, this is the first time that the bacteriologic findings described by Meleney have been confirmed.

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THE ELECTIVE TRANSVERSE ABDOMINAL INCISION

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Any attempt to break down a time honored tradition is always met with opposition, sometimes justified, sometimes not. This is especially true in regard to well established procedures in medicine and surgery. Yet with the wide open mind possessed by our profession there is that tendency toward improvement which prompts us to admit the value of something which we have been reluctant to adopt. This statement applies especially in the matter of abdominal incisions. The technic of the transverse abdominal incision is not new and has its disadvantages as well as many advantages. Contrary to the prevailing opinion, it has sound anatomic and physiologic bases, and in resurrecting this item of surgical technic for discussion, we wish to point out these anatomic considerations together with the indications and contraindications for the use of this type of incision. In view of the many good and detailed reports, it is our intention to confine ourselves to the salient features of the anatomy, physiology and technic, and to give further consideration to the experiences of other surgeons.

The object of any abdominal incision is threefold, namely: (1) adequate exposure; (2) secure and reliable closure, and (3) prevention of hernia. Thus we feel that this incision fulfills, under proper indications, these requirements better than any other.

We were led to adopt the use of the transverse incision in the upper abdomen through the good reports of others, and after searching the literature we were convinced that this was a rational procedure. Most of the articles dealt with the decrease of postoperative herniae following this incision, and this perhaps was the strongest factor in inducing us to employ it. Furthermore, in the use of the vertical incision, the first procedure after opening the peritoneal cavity is usually its conversion into a transverse incision by lateral retraction, sometimes such great force being necessary, for the proper exposure, as to traumatize the structures of the abdominal wall.

Historical Résumé.—It is not certain who was first to use the transverse incision in surgery of the abdomen. Its evolution, however, is quite interesting. It is known that it was used by Baudelocque for cesarean section prior to 1847. Trendelenburg had occasion to use it in 1882 in surgery in the urinary bladder. Kustner, in 1896, proposed transverse incisions at the pubic line for pelvic operations, primarily for cosmetic reasons. In the same year J. W. Elliott of Boston made a transverse incision in the skin beginning at the edge of the rectus, as a modification of McBurney's incision. Pfannenstiel began in 1898 and reported in 1900 his suprasymphyseal transverse incision of the skin and fascia with median division of the deeper tissues for operation upon

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the uterus and adnexa. This incision was being used at the same time by Stimson of New York and Hartmann of Paris independently, and was reported later.

To A. E. Maylard, Glasgow, Scotland, in 1898, is conceded the priority for the use of the transverse incision through the complete thickness of the upper abdominal wall. A word might be said about his first case. He had performed a gastric operation through a median incision supplemented by an incomplete right transverse extension. Due to internal hemorrhage reoperation was necessitated the same day. He states, "The wound healed with a result which showed a perfectly secure and non-yielding cicatrix of the transverse incision but marked tendency to hernial protrusion of the median one." This to Maylard seemed contrary to expectation but when reasoned anatomically, seemed logical. This case led him to further work and in 1907 he reported 45 operations for pelvic work, all through complete transverse incisions above the semilunar fold of Douglas.

In 1906, Boechmann, of St. Paul, Minn., began the use of the transverse abdominal incision in all types of abdominal surgery including extraperitoneal as well as intraperitoneal operations. He was under the impression, until he wrote his very complete paper in 1910, that this type of incision was original with him. At the time of the publication of his paper in 1910, he reported 400 cases in which the incision had been employed, more than 300 of which were in the lower abdomen, with the end-result of one hernia.

Boechmann's work was watched with favor by Hasselgrave, of St. Paul, Minn., who began its use in 1907, and reported, in December, 1910, 128 cases of operations above and below the umbilicus, on all types of abdominal surgery, without any hernia. He was particularly impressed with the good end-results following drainage in infected cases.

In 1910, Sprengel, of Germany, introduced into Europe and strongly advised the use of the transverse incision in the upper abdomen. His work was given impetus by Bakes of Germany the following year when he reported 297 cases with no postoperative herniae.

Since that time papers have intermittently appeared in this country and abroad favoring the use of this incision. Among those advocating this technic in later years are Meyer, 1915; Moschowitz, 1916; Farr, 1917; Quain, 1917; Moore, 1922; and Bartlett, 1933.

Anatomy and Physiology.—The anatomy of the region concerned is not complex. Since the skin is the first structure incised, it is sufficient to mention and observe that the skin cleavage is transverse to the long axis of the body. The muscles concerned are eight, the six flat muscles, splinted vertically by the two recti abdomini. The fibers of these flat muscles are transverse anteriorly, as their aponeuroses converge to ensheath the recti, and are inserted into the linea alba opposite each other.

The rectus sheath above the semilunar fold of Douglas is a firm and important anatomic structure. It is formed anteriorly by the aponeurosis of the external oblique and the anterior lamellae of the aponeurosis of the internal oblique, and posteriorly by the posterior lamellae of the internal oblique

and the aponeurosis of the transverse abdominus. The fibers of all of these structures course in a transverse direction. Therefore, in closure of the transverse incision the sutures are inserted at right angles to the fibers and not parallel to their long axes.

The recti are crossed by three fibrous bands, the tendinous inscriptions (transverse lines) usually situated at the umbilicus, at the inferior border of the xiphoid process and midway between. These bands extend halfway through the muscle and give to it a segmented effect and are intimately adherent to the anterior sheath. They are constant and are of value, first, as a landmark in this incision (since the seventh, eighth and ninth nerves as a rule enter the rectus sheath immediately below them [Blair]), second, they prevent the retraction of the several ends of the recti, and third, they form a double anchorage in closure.

Laterally where the flat muscles converge to ensheath the recti, their fibers run in their normal obliquities, which should be remembered when the incision has to be lengthened, in which case the fibers are separated in their normal planes.

The parietal motor nerve supply to this region is derived from the anterior divisions of the seventh, eighth, ninth and rarely a terminal branch of the tenth thoracic nerves, the so called thoraco-abdominal intercostal nerves. They course obliquely from their origins between the intercostal muscles to the midaxillary line where their course becomes transverse. Then they pass from behind the costal cartilages, between the internal oblique and transverse abdominus to enter the rectus sheath. The main trunk is posterior to the rectus muscle sending branches to it and terminating as the anterior cutaneous branch which pierces the rectus sheath supplying the skin. Midway in their course they give rise to the lateral cutaneous nerves which pierce the external intercostal and oblique muscles supplying the skin. It is thus noted that the main nerve and even its minute branches course in a transverse direction in the operative site. The position of these three nerves is rarely changed (Blair). It is needless to mention the importance of the maintenance of nerve supply to any structure.

The blood supply to this region is derived chiefly from the superior and inferior epigastric arteries. Here the incision cuts at right angles to the long axis of the vessels but the anastomosis on the rectus sheath is so profuse that their severance is negligible, as may be seen in any authoritative dissection.

The physiologic action of the abdominal muscles depends upon the fixation of the thorax, pelvis, and vertebral column; for example, if both pelvis and thorax are fixed, the muscles compress the abdominal cavity, in which case they are materially assisted by the descent of the diaphragm. If the pelvis and vertebral column are fixed, the muscles compress the lower thorax, assisting in expiration, *etc*. If the pelvis alone is fixed, the thorax is bent directly forward. If the thorax alone is fixed, the pelvis is brought upward. The recti acting above flex the pelvis on the vertebral column, and if below flex the thorax on the vertebral column.

When the flat muscles on both sides contract they compress the abdomen,

their power being delivered through the recti sheaths to the midline in the direction of the long axis of their fibers, so that there is the normal tendency of a vertical incision to be pulled apart, whereas coughing, sneezing, straining, *etc.,* would tend to relax and approximate the wound in a transverse incision.

Sloan, in his paper, states that there is 30 times more pull in vertical closures than in the transverse. He has proven experimentally in the operating room that in vertical incisions there is from 20 to 50 pounds' pull on the posterior aponeurosis alone in lightly anesthetized patients. This work has been confirmed by others.

Therefore postoperative patients, in whom the vertical incisions have been used, will, because of pain, splint their incisions by inhibiting normal thoracic and abdominal respirations, thus favoring atelectasis and pulmonary hypostasis.

Operative Technic.—To those who have never employed the transverse incision, it might seem cumbersome and awkward, and that much time is spent in opening and closing the abdomen. However, repetition and familiarity with the procedure will overcome this.

The level at which the incision is made depends on the pathology present, and we advise the procedure only in elective cases with clear cut pathology. Thus if roentgenologic examination shows a pathologic high-riding stomach, diseased gallbladder, or colon carcinoma, *etc.,* the incision is made accordingly at the indicated level. However, if emergency laparotomy is indicated, a line one inch above the umbilicus is chosen.

A transverse incision is made through the skin and superficial fascia, down to the recti sheaths at the indicated level. The sheath is bared a half inch to each side of the skin incision, keeping in mind subsequent closure. The wound is walled off with sterile skin towels. The tendinous inscriptions are identified, and if convenient, the recti sheaths are opened transversely just above them. The recti muscles are then severed through their entire thickness to the posterior aponeurosis, care being taken not to cut suddenly into the peritoneal cavity at the midline, though if such were to happen the abdominal viscera are, as a rule, protected at this vulnerable point by the falciform ligament of the liver. At this stage, there may be variable bleeding from the recti muscles, at times moderately profuse, needing ligation, other times negligible. The peritoneal cavity is then opened by any of the accepted methods, following which the falciform ligament must be severed between clamps and then ligated. Usually the stomach and transverse colon present themselves, depending on the level of the incision. There is not that tendency of automatic evisceration as in the vertical incision, and if the above are not the seat of pathology they are easily packed off, requiring less gauze than usual. If the gallbladder elevator is employed, there is good exposure with free access to the gallbladder, biliary ducts, stomach, pylorus, duodenum, pancreas and transverse colon.

In closure, a breaking type of operating table is of distinct advantage, for if the patient is "jack-knifed" slightly the wound margins fall together easily, and respirations do not disturb their approximation. The falciform

ligament is united at times separately, and at times with the continuous
peritoneal suture. The peritoneum, including the posterior aponeurosis, is
closed with a continuous suture and it will be found that there is extremely
little tension on the suture line. In addition, the sutures are going in at
right angles to the aponeurotic fibers, so there is no tearing. If tension
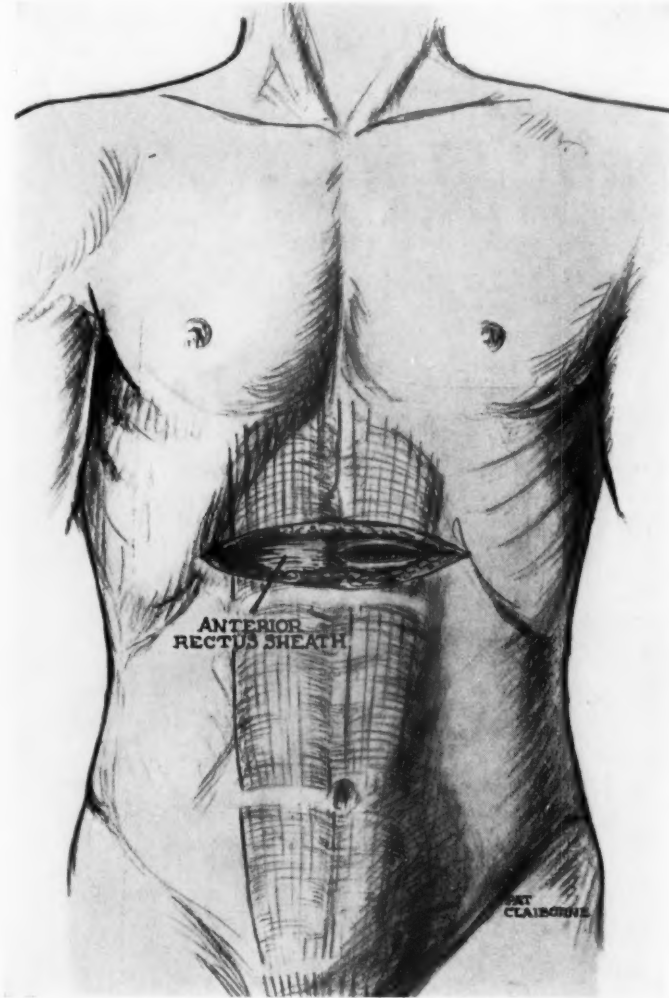

Fig. 1.—Illustrates the level and line of incision approximately midway
between xiphoid and umbilicus immediately above the second tendinous in-
scription.

sutures are elected they are inserted at this point, although we have not
found them necessary except in contaminated cases. The recti muscles are
occasionally approximated with several mattress sutures of No. o catgut, but
their repair, as a rule, is ignored. The anterior sheaths of the recti are then
closed with interrupted or figure of eight silk sutures, after which the skin
is closed with interrupted silk.
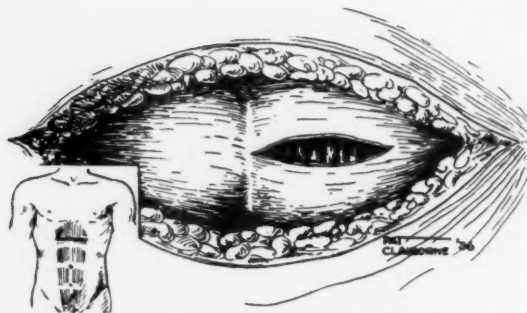
FIG. 2.—The incision made through the skin and superficial fascia. The fascia cleaned, and the left anterior rectus sheath incised. The transverse fibers of the anterior rectus sheath and the vertical fibers of the muscle are sketched. Inset shows the line of incision through the rectus sheath and muscle.

POST. RECTUS SHEATH and PERITONEUM
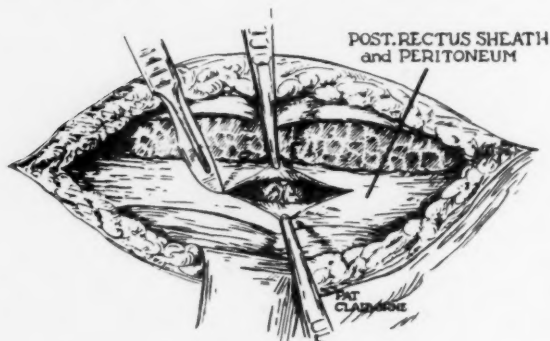
FIG. 3.—Both recti muscles severed, bleeding controlled, the posterior rectus sheath with peritoneum being opened in the midline. The falciform ligament of the liver presents.

CONTINUOUS NO.1 CHROMIC
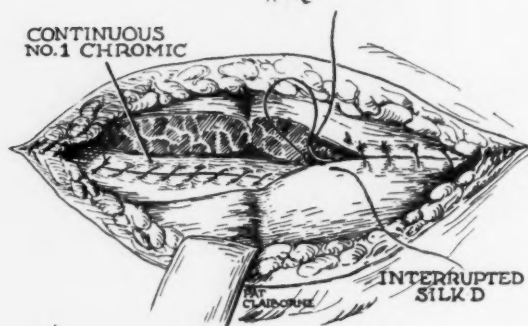
INTERRUPTED SILK D

FIG. 4.—Peritoneum and posterior rectus sheath, together, closed with a continuous suture of No. 1 chromic catgut. Left anterior rectus sheath being closed with interrupted D silk sutures.

FIGURE 8 SUTURE AT MIDPOINT OF RECTI M.

Interrupted Silk D

Interrupted vertical mattress Silk A

DRAIN EXIT AT EITHER EXTREMITY OF INCISION
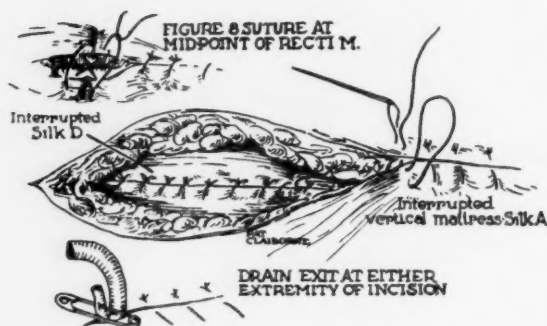
FIG. 5.—Both anterior sheaths closed with interrupted sutures of D silk. Skin and superficial fascia being closed with interrupted vertical mattress sutures of A silk. (Inset above)—Insertion of a figure of 8 silk suture at the midpoint of the recti, securing all four points on the two sheaths. (Inset below)—Illustrated exits of drains at the extremity of the wound. In this instance a cholecystostomy tube and a small rubber subhepatic drain is shown.

When drainage is necessary, the drains are placed in one or the other extremity of the incision. (At this clinic, almost without exception, all cholecystectomies are drained.) Thus the drainage tract is straight, and the drains remain secure without bending or tension. When they are finally removed, the wound heals rapidly without thickening of the scar. If, for any reason, contamination of the abdominal wall is feared, a gutta-percha or a split Dakin tube can be placed under the recti muscles and emerge at either extremity of the incision. We refer those interested in a further pursuit of this problem to the papers of Moschowitz, Hasselgrave, Meyer, and Moore, who testify to the excellent end-results obtained, in drained and postoperatively infected cases, using this incision.

In reviewing the literature we find there are many writers who have used the transverse incision and advocate it over the vertical. Some are over-enthusiastic in proposing it in all types of abdominal surgery, others advising it only in elective cases. Too few, however, have accurately stated the number of cases in which it was employed. Some of its strongest supporters have not reported any cases. In the articles reviewed, only 1,763 cases were collected in which the transverse incision was used above the semilunar fold of Douglas (Table I).

TABLE I

COLLECTED CASES IN WHICH UPPER ABDOMINAL
TRANSVERSE INCISION WAS USED

Maylard	45
Boechmann	400
Hasselgrave	128
Bakes	297
Moschowitz	97
Quain	500
Meyer	8
Farr	150
Jones and McClure	125
Bartlett and Bartlett	13
	1,763

Doubtless the incision has been used many more times than has been recorded. Almost without exception all writers stress the decreased occurrence of postoperative ventral hernia. However, even in the above reported cases the postoperative study is poor and incomplete in this respect.

Statistical Résumé.—The writers' experience is limited, but in the past 18 months we have employed the transverse incision in 73 cases. The ages of the patients varied from four weeks to 84 years. It has been used on both men and women, white and colored. Some patients had had previous operations, some were obese, some thin and others muscular, so that it was used on almost every type of patient. One case particularly deserves mention. A colored man was operated upon for a perforating gastric ulcer at which time a gastrorrhaphy together with a sliding omental graft and pos-

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terior gastro-enterostomy were performed. The abdomen was closed without drainage. Six days postoperative he developed a wound infection which involved both aponeuroses of the recti; it increased in severity until an abscess formed which dissected its way down the right side of the abdomen and pointed in the scrotum. Drainage and irrigation were instituted, and after a rather long convalescence the patient was discharged, recti healed and the wound firm. He has been examined repeatedly and at the end of 12 months the recti are still firmly united but there is a fusiform ventral hernia presenting in the midline.

The 73 cases that were operated upon are divided as follows: gallbladder, 32; stomach, 20; duodenum, 7; colon, pancreas, spleen, and adhesions making up the remaining 14. Among these cases 12 appendectomies were performed at the same time. Forty-one of the 73 were drained.

There have been 13 deaths in this group of patients. Carcinomatosis, 8; cardiac failure, 2; aspiration pneumonia, 2; and pulmonary embolus, 1.

In our follow up study there has been one hernia found and five patients we were unable to contact.

Advantages and Disadvantages.—Continuing the brief discussion above we shall now specifically recapitulate the advantages and disadvantages of this procedure to the patient and the surgeon.

Advantages to the Patient:

(1) Less anesthetic necessary, for when the recti are severed there is no rigidity to overcome.
(2) Greater protection and less shock is offered, since the intestines are retained in their normal cavity, necessitating neither handling nor exposure.
(3) Less gauze packing is necessary.
(4) Less wound reaction, due to elimination of forceful retraction.
(5) Firmer aponeurotic union, therefore less postoperative hernia.
(6) Less pain, as postoperative movements of vomiting, coughing, straining, *etc.,* tend to approximate, rather than pull on, the suture line.
(7) Less pulmonary complications (Jones and McClure), since with less splinting for pain there are freer thoracic and abdominal excursions, thus less pulmonary hypostasis and atelectasis.
(8) Cosmetic result is better, and even in drained cases there is no stellate scar resulting.

Advantages to the Operator:

(1) Anatomically correct—the incision is in line with the skin, and aponeuroses of the recti. It also leaves the nerves intact, thus decreasing risk of hernia.
(2) Physiologically correct—not only in closure, but postoperatively, respirations tend to approximate the wound margins rather than pull them apart.

(3) Incision gives excellent exposure.

(4) Retractors rarely necessary.

(5) The incision facilitates easy delivery and replacement of viscera.

(6) Incision gives easy, secure, and reliable closure, in that there is no
tendency to peritoneal tearing.
Muscle fibers cut at right angles heal more rapidly (Moore).
Sutures are inserted at right angles to the recti aponeuroses, not parallel.
Tension sutures rarely necessary.

(7) The incision facilitates direct and comfortable drainage, without ten-
sion on the drain and with minimum risk of subsequent herniation.

(8) There is decreased tendency to fascial slough over vertical incision
(Meyer).

(9) There is diminution of cicatrix when reopened (Moschowitz).

(10) There is better behavior and there are better end-results in presence of
infection (Meyer, Moschowitz, Hasselgrave).

Disadvantages:

(1) Anatomically—the incision cuts across the recti muscles. To refute
this disadvantage we refer to Moore's article, in which he discussed,
microscopically, the rapidly healing vascular edges of the recti muscles;
but a still better reference that these severed recti heal rapidly, securely,
and reliably will be gained by actual experience in the use of this incision
and repeated examinations of the patients postoperatively.

(2) Bleeding—as stated above is variable and in some cases more time is
consumed in ligation than in vertical incisions, at other times consider-
ably less. There is, however, no permanent damage to blood supply.

(3) We do not find or claim this as the ideal incision for free access to all
of the abdominal viscera.

CONCLUSIONS

(1) The transverse upper abdominal incision has rational anatomic and
physiologic bases.

(2) It eliminates extensive packing off of surrounding viscera.

(3) It reduces the handling of viscera to a minimum.

(4) Postoperative discomfort in the form of gas pains is rare.

(5) The incidence of postoperative herniae is greatly reduced.

(6) In our experience pulmonary complications have been less frequent.

(7) We believe the transverse abdominal incision is ideal in elective cases
of clear cut pathologic conditions in the upper abdomen, giving us most
satisfactory exposure of the diseased process and an easy, secure, and
reliable closure of the abdominal wall.

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[1] Blair: Surg., Gynec., and Obst., vol. 1, p. 152, 1905.
[2] Davis, G. G.: ANNALS OF SURGERY, vol. 43, p. 106, 1906; vol. 44, p. 720, 1906.
[3] Maylard, A. E.: Brit. Med. Jour., vol. 2, p. 895, 1907.

type of incision, also in the common method of repairing umbilical hernia, by overlapping the fascia in an up and down manner, rather than transversely. If we measure the pull upon the posterior sheath of the rectus muscles, in a transverse direction, we will find that it is tremendous. Since the internal oblique and transversalis are respiratory muscles, in the act of coughing or vomiting this pull is greatly increased and occasionally it does not hold if sutured in a vertical direction. Therefore, we believe that these fascial structures should never be cut vertically if it can be avoided.

Extensive dissection of the skin incision is generally repulsive to the average surgeon, when he desires to get into the abdomen quickly, and often he is too impatient to take the time to make the proper incision. We can safely say that the time for the entire operation is not longer, because the closure of the wound is so much more quickly and easily done, than in the other type of incision. I have no doubt but that every surgeon who familiarizes himself with this incision will get a tremendous amount of comfort and satisfaction in its use.

DR. ROBERT L. SANDERS (closing).—I am pleased that Doctor Singleton has discussed these essays, as he is one of the pioneers who has done excellent work on this problem of transverse incisions in the upper abdomen. I would like to emphasize the fact that there have been two types of incision, one of them dividing the recti muscles and the other retracting them but leaving the fibers intact. Both of these methods are presented in these papers. Doctor Lynn advocates division of the muscles, while I call attention to the method of retraction of the muscles without division of their fibers. By this conservation of the continuity of the muscle fibers, the anatomic and physiologic relations of the abdominal wall are not disturbed and its integrity is maintained. This procedure has been very satisfactory in our hands.

SACROCOCCYGEAL TRANSRECTAL APPROACH FOR REPAIR OF HIGH RECTOVAGINAL AND VESICOVAGINAL FISTULAE

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THE literature concerning the repair of persistent high rectovaginal fistulae deals with various methods of approach, either directly, through the posterior vaginal fornix, or perineally by separation of rectum and vagina up to the region of the fistula. In either case, dissection of the fistulous region with separate closure of the openings in rectum and vagina, attempts at the same time, if feasible, to have the two closures not directly opposite one another. Cutting the anal sphincter or temporarily paralyzing it by stretching, as well as temporary left inguinal colostomy, has been mentioned as useful in putting the operative field at rest until healing has taken place. Suggestions have also been made for various transperitoneal abdominal procedures with the same object in view. A recent experience seemed to suggest a more direct approach to this relatively inaccessible region.

Case Report.—A case of low rectosigmoidal carcinoma was operated upon in the Skin and Cancer Division of the New York Post Graduate Hospital August 21, 1935. The patient was a rather emaciated woman of 54. The tumor was free and its lower margin was just above the bottom of the pouch of Douglas. Through a median hypogastric incision, the tumor-bearing loop was completely mobilized according to the procedure of Miles, without, however, division of the inferior mesenteric vessels. The mobilized loop was then packed down into the pelvis, the pelvic peritoneal diaphragm reestablished, and the abdomen closed. A Mikulicz "vorlagerung" of the mobilized tumor-bearing loop was performed through a sacral approach after removal of the coccyx.* Six days later, August 27, the tumor-bearing loop was amputated flush with the skin. On the tenth postoperative day, August 31, a spur-crushing clamp was applied, which came away at the end of seven days. The spur was, however, not completely divided. With the index fingers in the afferent and efferent loops respectively, it was possible to bring the finger tips together with what seemed to be bowel between. September 19, the clamp was again applied to this spur and at the end of ten days it cut through, but the posterior fornix of the vagina had been caught in with the efferent loop, so that a high rectovaginal fistula, in the median line, fully five centimeters long resulted, with its upper end at the cervical wall. From the vaginal aspect, this rectovaginal fistula was fully three and one-half inches from the perineal margin of the posterior vaginal wall. Through the sacral colostomy opening, however, the distance was not more than three-quarters of an inch from the skin. On October 9, 1935, without enlarging the sacral colostomy opening, it was a simple matter to expose the fistula, dissect the anterior rectal wall from the posterior vaginal wall, and to mobilize both for fully one-half inch from the margins of the opening. The vaginal opening was then closed in two layers, with running sutures of chromicized catgut. The rectal mucosa was readily

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* Küttner (Zentralblatt für Chirurgie, p. 604, 1910) reported ten such cases of sacral Mikulicz "vorlagerung" for carcinoma of the rectosigmoid with one death.

approximated. There was no leakage, and, at the end of three weeks, a firm healing had apparently taken place. During this time there was no tension on the plastic repair because the open sacral colostomy, directly opposite, allowed free escape of feces and flatus.

On November 14, under spinal anesthesia, the sacrococcygeal colostomy was closed. A circular incision at mucocutaneous margin freed the intestinal wall liberally, so that the lozenge-shaped longitudinal opening of mobilized posterior rectal wall could be sewed up in a transverse direction. The skin margins were then approximated, except at one point just below end of sacrum where a vaseline gauze drain was inserted. This drain was removed at the end of the third day and the posterior wound gradually healed without leakage. The rectovaginal repair, however, leaked a little for 13 days and then closed spontaneously. Six weeks later the patient reported that there had been no further leakage; regular normal bowel movements, and a gain of ten pounds in weight.*
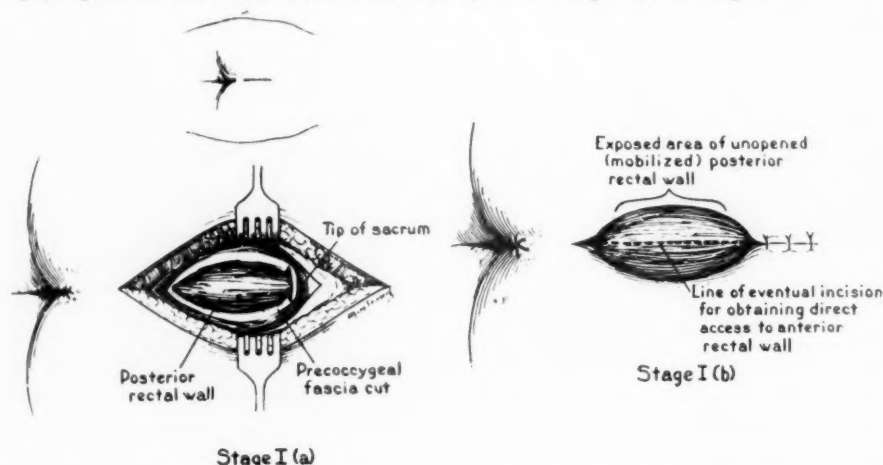

FIG. 1a.—Beginning the exposure of the posterior rectal wall after removal of coccyx and division of precoccygeal fascia.

FIG. 1b.—Rectum has been mobilized sufficiently to permit a longitudinal area of the posterior wall to heal in place, level with the skin surface.

This experience suggested that, in the repair of persistent high rectovaginal or rectovesical fistulae, where much cicatricial deposit might render mobilization and exposure difficult in following previously employed methods, the following sacrococcygeal, transrectal approach might be considered and performed in the appended three stages.

Operative Technic.—1. Exposure of the posterior rectal wall through a median incision, extending from over the lower end of sacrum to within one inch of the posterior anal margin, removal of coccyx (Fig. 1a), mobilization of rectum,† sufficiently to permit delivery of the unopened posterior

* Patient was presented before New York Surgical Society, January 8, 1936. A previous case operated upon according to this method was presented before the Surgical section of the New York Academy of Medicine, January 6, 1928 (Gerster, J. C. A.: Carcinoma of Rectum. American Journal Surgery, vol. 4, No. 4, April, 1928, pp. 444–445), and later before New York Surgical Society, January 14, 1931 (ANNALS OF SURGERY, June, 1931, vol. 93, pp. 1252–1253). She is living and well eight years after operation, January 8, 1936.

† The technic is the same as that described for mobilizing the rectum (for carcinoma), Text-Book of Operative Surgery, by Dr. Theodore Kocher, Third English Edition, translated by Harold J. Stiles. The Macmillan Company, 1911, vol. 11, pp. 651–652, Figs. 385, 386, 387.

rectal wall, so that it lies exposed in the wound at the skin level and in contact with the cut margins of the gaping skin wound (Figs. 1b and 2). A vaseline gauze dressing covers the operated area for a week or ten days to permit healing, thereby avoiding infection of the subcutaneous tissues.
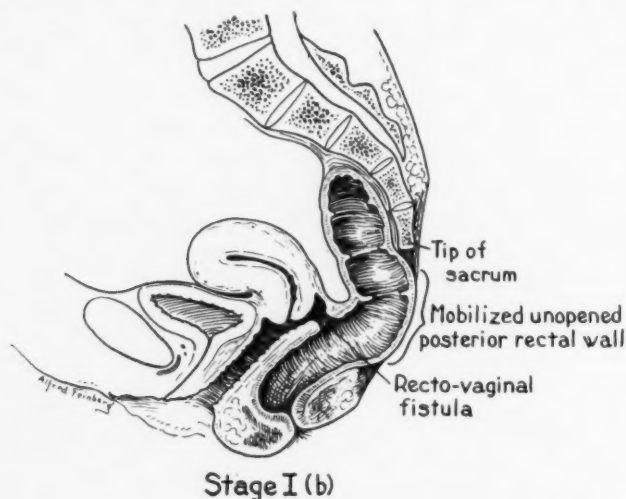

Stage I (b)

FIG. 2.—Sagittal section of the pelvis. Showing greater accessibility by sacrococcygeal attack than by perineal or vaginal routes.

2. The long oval of exposed bowel wall (Fig. 1b) can now be opened longitudinally with scissors, actual cautery or electric cutting knife. (This obviates the necessity of a preliminary abdominal colostomy.) With proper retraction, the fistulous opening in the anterior rectal wall lies in view directly

Stage II
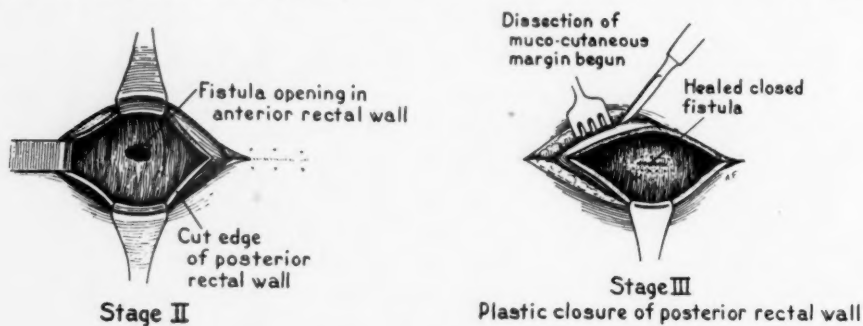
FIG. 3a.—Posterior rectal wall opened exposing fistula on anterior rectal wall. After transrectal plastic closure of fistula, posterior rectal wall remains open until complete healing of fistula is assured.

Stage III
Plastic closure of posterior rectal wall

FIG. 3b.—Plastic closure of the posterior rectal wall, only after healing of the rectovaginal fistula is assured.

opposite, accessible for repair (Fig. 3a). If the fistula fails to close completely, a second attempt at closure is, of course, feasible. During this period of healing, the presence of the colostomy opening directly opposite, permits free escape of feces and flatus, and thus avoids strain on the suture lines of the plastic repair.

3. Eventually, having satisfied oneself that the fistula is firmly and soundly healed, the sacral colostomy is closed as in final stage of any Mikulicz "vorlagerung" (Fig. 3b).

The advantages of this method are: simplicity, accessibility of the region to be repaired, less risk from infection or of failure than by either the perineal or abdominal route, and lastly, less cosmetic deformity than after other methods of attack.

In traumatic surgery with perforation of the bladder and rectum, it is suggested that, as an emergency measure, an immediate sacrococcygeal decompression of the rectum, as just described, be combined with a suprapubic cystostomy, to prevent infiltration of the pelvic cellular tissue with urine and feces. The method also may be used to approach certain rectovesical fistulae in the male.

SUMMARY

Recently in the course of cutting through the spur of a double-barreled colostomy after a Mikulicz "vorlagerung" for a low rectosigmoidal carcinoma through a sacrococcygeal opening, a high rectovaginal fistula was incidentally produced.

Repair of this fistula was so easily accomplished through the sacrococcygeal opening, that it is suggested that a deliberate attack by this route for the repair of certain suitable, selected cases of high rectovaginal or rectovesical fistulae is feasible.

URETERAL TRANSPLANTATION AND CYSTECTOMY

ADDISON G. BRENIZER, M.D.

CHARLOTTE, N. C.

COFFEY, in 1909, suggested the submucosal transplantation of the common bile duct or ureter, which procedure was carried out with a ureter by C. H. Mayo in 1912. He then further suggested introducing catheters into the ureters, transplanting them both simultaneously, and finally, the employment of a necrosing suture, transfixing the ureter and intestinal mucosa, after anchoring the severed and tied-off ureter to the intestine in the submucosal position.

Complications, however, arose with the necrosing suture: *i.e.*, (1) Apparently the suture used to tie off the distal end of the ureter should not be used as the necrosing suture, because the implanted ureter might slip its position. The fistula should be established proximal to the end tie, and the tied-off end of the ureter should be anchored to the whole thickness of intestine and not to the mucosa alone. (2) The suture, if tied loosely, failed to cut through, and if tied too tightly, would cut through the intestinal mucosa before cutting through the ureter. (3) The suture failed to enter the lumen of the intestine.

We felt that these difficulties could be overcome by using a metal ring. (1) If the needle bearing the suture were passed through the ring in the intestine, it would of necessity have passed through the intestinal mucosa. (2) There would be no question as to the security of the suture tie, as it could be tied securely and tightly down on the ring. (3) There would be no danger of shifting of the ureter, because the suture and ring held the ureter, with interposed intestinal mucosa in its grip. The suture would cut through the ureter into the intestine, more readily by the pull on the ring from intestinal peristalsis. Added to this, a thread tied to the ring and allowed to escape from the anus could be pulled upon at will and thus aid in the cutting through of the necrosing suture.

Walker-Taylor, in 1932, had already suggested the use of a metal ring. Coffey adopted this procedure, and found it easy to insert the ring on an ordinary curved forceps into the straight rectum of a dog, but difficult to introduce into the human rectum, which is directed backward and to the left, and contains valves and membranous folds. He devised an olive tipped, hollow ended curved forceps, to carry a ligature, through which the necrosing suture was to be passed.

It was found that an ordinary curved forceps, grasping a metal ring, could, without danger, be passed by all folds and valves, when carefully guided from above . If there was any difficulty in passage, the ring could be liberated from the forceps and rolled between the fingers to any position
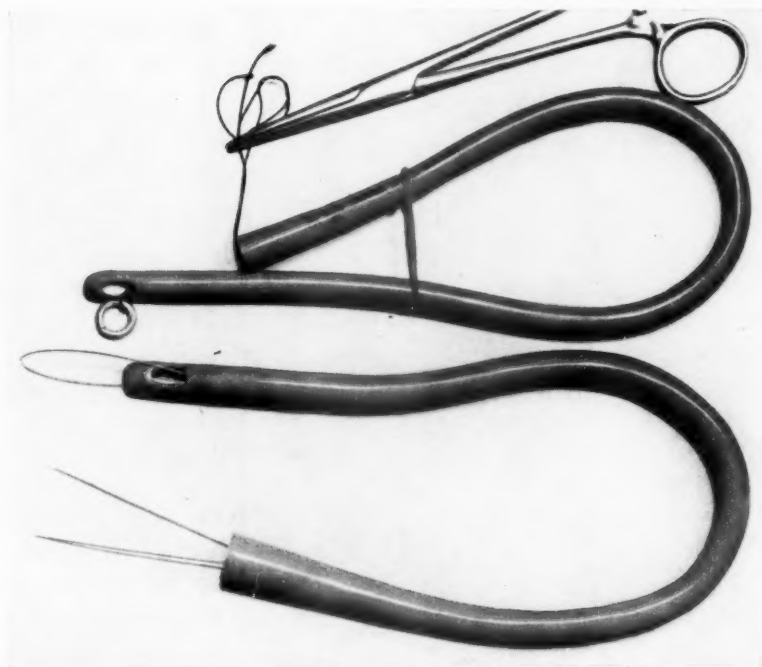
Fig. 1.—Small rectal tubes or catheters of size No. 26F., one threaded with silk holding a small metal ring. The ring is pulled close into the eyelet and passed up by rectum. The other catheter shows the way the long hairpin wire is passed over the ureter in the abdomen and down the catheter. It is better to use a single catheter with side and end eyelets for each ureter, the side eyelet to carry the ring up the rectum and the end eyelet to carry the hairpin wire down the rectum through the catheter.

Fig. 2.—The ring is shown in the rectosigmoid passed up in position and the catheter, for illustration, is grasped by an Allis forceps through the bowel wall. These rings may be swallowed, several of them the day before, and pushed up and moved to the proper position.

in the rectosigmoid. Or, for that matter, a ring could be picked up any-where along the extent of the colon by allowing the patient to swallow several small rin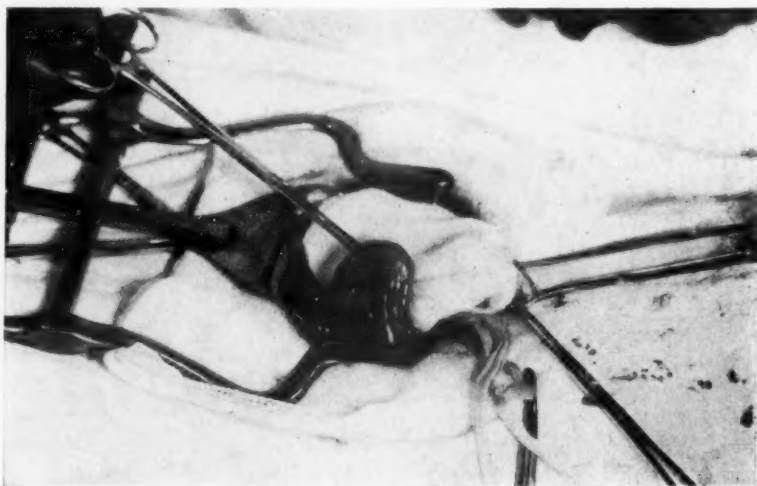gs the night before and at operation they could be identified and transferred to any desired position. We have used several sized rings, with or without a tugging thread. A flexible Ochsner stylet and gallbladder probe and a piece of tonsil wire bent like a hairpin were used to pierce the ureter and then be passed down a catheter in the rectum.

Higgins,[1] in 1933, while still employing the submucosal position of Coffey and his necrosing stitch technic, began to experiment on dogs, performing a simultaneous bilateral transplantation of the ureters. Walters, in 1933, stated that: "Higgins has modified this method (the transfixion and necros-ing suture method) by not dividing or occluding the ends of the ureters until the ureterosigmoidal anastomosis has established itself; he prefers division or occlusion later, when the bladder is removed. In an experimental study of the socalled aseptic, suture-necrosis method, Mann and I found that im-mediate or eventual hydronephrosis occurred so frequently, even though urine appeared in the rectum from the fourth to the sixth day in most cases, that I have been fearful to use the method clinically." Higgins, in 1934, stated: "I have collected a series of 52 cases with three fatalities. We are more than enthusiastic over the results we have secured with its use during the past year."

My opinion, from what I can gather from various sources and from my own experience, is that there is no objection to the necrosing suture method, when properly applied, to create an appreciable fistula between the ureter and intestine, and that the lateral anastomosis without interruption of the continuity of the ureters, of Higgins, is the one revolutionary suggestion and most ingenious method since the original "submucosal transplantation" of Coffey.

ILLUSTRATIVE CASE REPORT
In Which Higgins' Technic Plus the Ring Was Employed

W. M. H., a Negro girl, aged 15, had had a difficult forceps delivery the previous year. The anterior wall of the vagina and bladder were badly lacerated, leaving a large, scarred, irreparable vesicovaginal fistula.

Operation.—General anesthesia (gas-ether). Midline incision below the navel, Trendelenburg position, whole pelvic basin exposed. Both ureters easily identified with-out catheters, peritoneum incised and ureters gently stripped from their bed for an extent of three inches, as low as possible along the pelvic wall where they could be most conveniently laid against the rectosigmoid. Incisions were made into the recto-sigmoid, lower on the left side than on the right, through the serosa and muscularis down to, but not into, the mucosa. The ureters were placed in their submucosal beds, for a distance of about one and one-half inches and anchored in place at their lower ends by taking a stitch twice through the ureters and once through the intestinal mucosa and ring, which was held like a darning egg in the rectum against the mucosa. The ring, tied with a silk thread, and held by a long curved forceps, had been placed in the rectum before the operation began. There had been no cleansing of the recto-sigmoid other than by an enema. The competency of a lacerated perineum had been

proven by the injection of water and air. The rings were pushed up from below, while being guided from above, until they reached the desired position, when they were grasped with Allis forceps applied through the whole intestinal wall, thus estab-
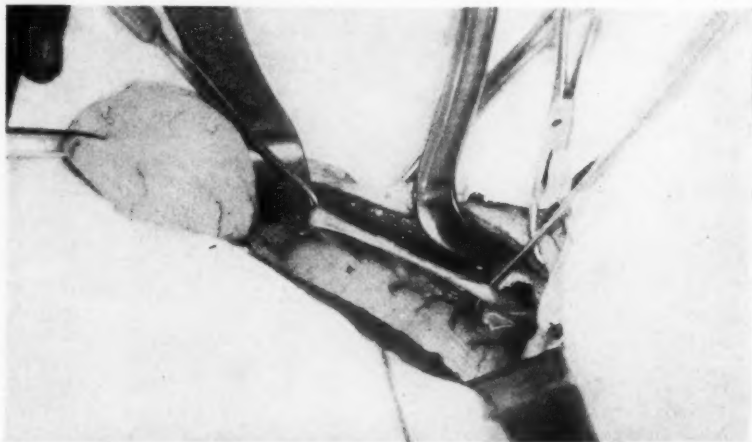
FIG. 3.—Exposure of the rectosigmoid, bladder and ureter; the ureter is held on two blunt hooks.

lishing a fixed point, holding the intestine perfectly and serving to facilitate the incision down to the mucosa and the laying of the transfixion and necrosing stitch through the ureters and through the rings. These silk necrosing sutures were tied securely on the
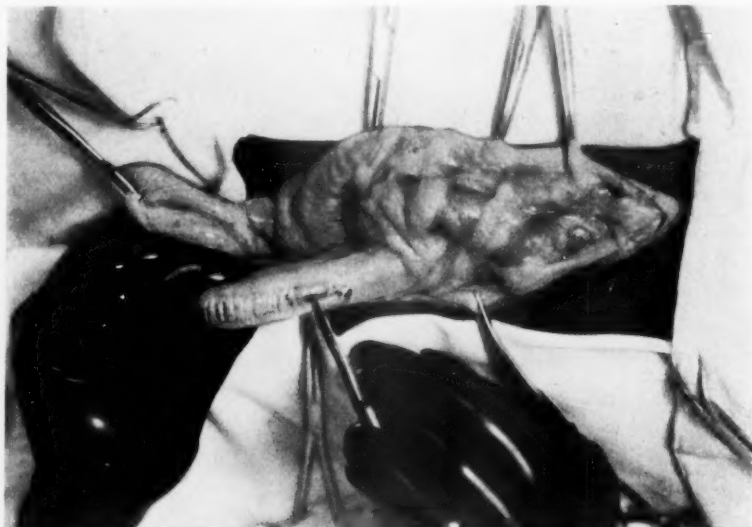
FIG. 4.—The catheter and ring shown in Figs. 1 and 2 are shown; the catheter grasped and used as a darning egg is cut down upon incising muscularis down to the mucosa. The ring in the bowel against the mucosa is being pointed out with the knife at the top angle of the incision.

rings. The muscularis first, and then the serosa were sutured over the ureters with a Lembert stitch of No. 0 chromic catgut. The lateral flaps of the parietal peritoneum were then sutured, over this line of suture, to the rectum.

The bladder was pushed away from the peritoneum above and around to the sides,

forcing it as far as possible under the symphysis, and in closing the peritoneal wound the peritoneum was anchored high to the muscle and fascia, thus beginning the liberation of the bladder and creating a much larger preperitoneal space for the anticipated cystectomy. Two Penrose drains were placed in the bladder space for 48 hours.
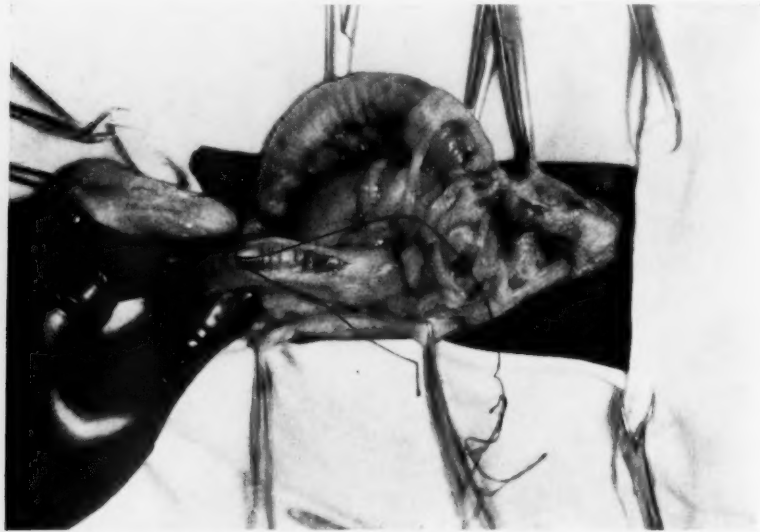
FIG. 5.—The catheter in the rectosigmoid with the ring is now pulled down two-thirds the length of the incision; then a silk suture is first made to pierce the ureter and then through the ring in the bowel and the ureter is tied down on the ring. The figure illustrates the site of the ring and the suture through it. This is the necrosing suture.

There was but little postoperative reaction. The urine began to flow per rectum within 48 hours. The rings bearing the necrosing ligatures came away on the sixth and tenth days respectively. The fistulae were established by gentle traction on the
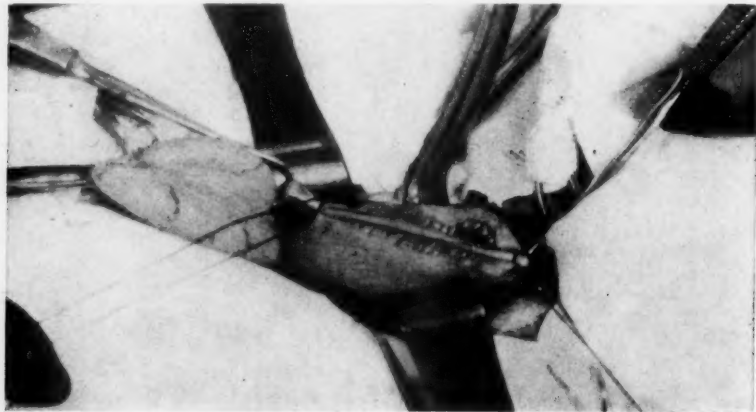
FIG. 6.—Incision down to the mucosa, stretch of ureter about two inches long lying on mucosa and held in position by two interrupted Lembert sutures, one at each end.

rings some time before complete necrosis had occurred, which allowed their ultimate liberation.

The cystectomy was completed a month later. On account of the separation of the peritoneum and its anchorage in a higher position, and the separation of the bladder

at the first operation, there was very little hemorrhage. The ureters were identified as they entered the bladder and as they tugged upon the rectum when pulled upon. A small slit was made into the peritoneum, the distal portion of the ureters clamped at the point of emergence, tied with chromic catgut, and tucked into the rectum. The small peritoneal opening was sutured. The dissection of the bladder was carried down to the scarred opening high in the anterior vaginal wall, which was left open for subsequent drainage. The mucosa of the trigon and the posterior urethra was hollowed out by dissection and cautery. Two Penrose drains were inserted, one above and one below. The postoperative course was uneventful.

After the wide separation of the bladder at the first operation, the removal of the bladder from below was considered, but abandoned because: (a) The approach would have been through a urine drenched field; (b) the high position within the abdomen, where the ureters emerged from the rectum, would have been difficult to reach; and (c) the opening of the
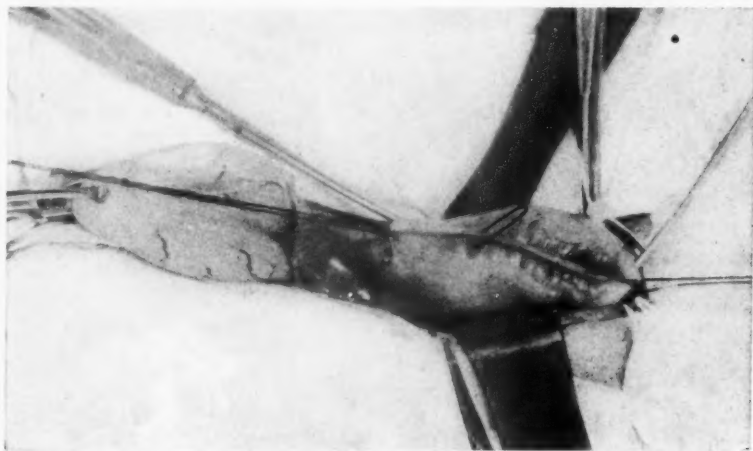

FIG. 7.—Hair, in wire looped over the ureter, about one-half inch above the lower angle, and passed through the mucosa down the end eyelet of the catheter and out of the anus. It is this wire, which will cut through the ureter on the tenth day either by pressure necrosis from traction or by burning under the application of an electrocoagulation current. This severing of the ureter is done after the fistula between the ureter and bowel is secured by the cutting through of the necrosing suture on the fourth to sixth day. Traction on the hairpin wire may be secured by attaching the ends of the hairpin wire to a rubber band stretched between the legs. The final technic of the operation will dispense with the necrosing suture and produce the fistula and at the same time sever the ureter with a single hairpin wire over each ureter.

peritoneum by this route might have caused infection. In addition, by severing the ureter at the bladder, without reoperation and without reopening the peritoneum, a fistula may remain, which can be removed from below. The bladder can be more readily separated when outlined under gentle distention, which is not applicable if fistulae are present. Care is required to remove the bladder intact with ureters attached. Nevertheless, with the separation at the first operation, which can be nearly complete, so long as the ureters remain attached intact, and will flow, the bladder in the female can be removed from below, along with the urethra through the vagina.

Feeling that if a loop of tonsil wire No. 9 or less, could be looped over the ureters they could be severed in position, without removing the bladder,

FIG. 8.—One wire loop holding down the lower end of the ureter, the loop to sever the ureter. A second wire loop, above this one, transfixing the ureter, to cut through by necrosis or burning and create the fistula or uretero-enterostomy.
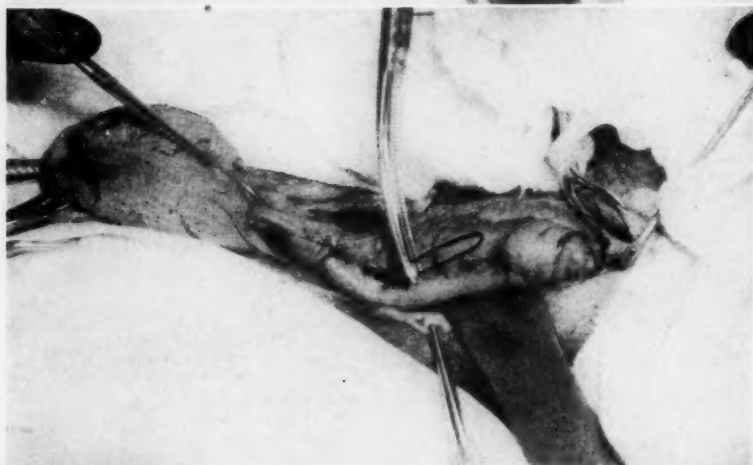
FIG. 9.—The muscularis and serosa of the rectosigmoid is closed over the stretch of the ureter, lying on the mucosa. The hairpin wire, looping over the lower end of the ureter and passing through the mucosa and out the anus, is pushed back up through the stitch line to illustrate its position, well above the emergence of the lower end. It is this wire which severs the ureter.

FIG. 10.—The ureter lying on the rectal mucosa, the hairpin wire loop, pulling down on the lower end and emerging through a rectal tube by rectum. The electrocoagulation electrode being applied, first to transfixion wire, creating this fistula and then to the looping wire severing the ureter.

or, if the bladder were removed, the operation would be simplified by having
the ureters already occluded and embedded, the following technic was
evolved: A rectal tube was inserted into the rectum. Both ureters were
rapidly exposed. Two incisions were made into the rectosigmoid through
serosa and muscularis down to the mucosa. A piece of tonsil wire was
bent like a long hairpin and looped over the lower end of the right ureter
and passed through the mucosa, at the lower end of the incision, into the
open end of the rectal tube. The rectal tube was shifted down and the
same procedure performed with the left ureter. The muscularis and serosa
were closed over the ureter. The lower ends of the transfixion wire were
bent for identification and attached to slight elastic tension. After three
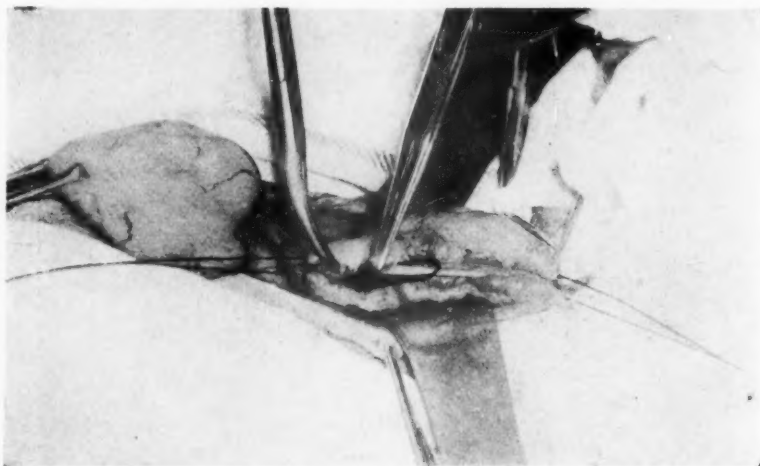
FIG. 11.—The two ends of the ureter after cutting with the hairpin wire loop on
applying the electrode of the cutting current below. The loop is again pushed up over
the ureter (shown just above the upper clamp). If the ureter is pulled down upon hard
by the loop and the current is very weak, there is practically no damage to the surrounding
intestine and the ends pull apart for some distance. The fate of the upper burned end
depends upon the function of the fistula (uretero-enterostomy) above it. Either closed
or open would be satisfactory.

days, under the guide of a proctoscope, a small rectal tube was passed over
the transfixion wire to insulate it and the wire was touched with an electro-
coagulation electrode, which resulted in the wire cutting through. On the
twelfth day the lower wire, looping the ureter, was pulled down upon hard,
and a low current applied to the electrode so that the effect would be not
only to cut slowly through the ureter and rectal mucosa and not to necrose
the tissue except for a slight distance around, but also, through the pull,
to dislodge the ureteral ends. Here the great advantage lay in not having
to reoperate to disconnect the ureters from the bladder and another definite
feature was not having to reenter the peritoneum, even when carrying out
the cystectomy.

The fate of the looped and severed lower end of the ureter should depend, in
large part, on the function of the fistula above it. If functioning actively, the
lower end would probably close. It might, however, discharge urine, but as

the place where it is severed lies behind serosal flaps, it would be likely to close with the aid of intra-intestinal pressure, as in an enterostomy. If this should fail, there is still another opportunity to close it when the bladder is removed. Thirteen ureters thus far have been transplanted in man, and innumerable ones in dogs.

RÉSUMÉ OF TECHNIC.—None of these cases has had any particular
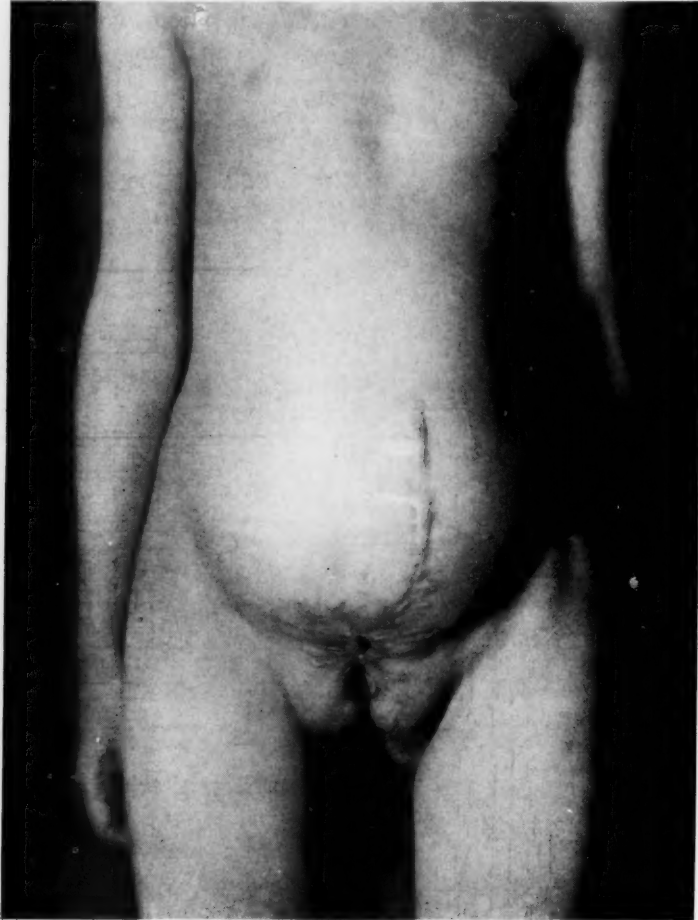
FIG. 12.—Case of exstrophy of the bladder, after transplantation of one ureter at a time according to Coffey technic No. 3 and the Brenizer ring technic and removal of the bladder. Now awaiting a better plastic procedure of the bladder and vulval regions.

preparation of the rectum and colon beyond emptying them. An empty and dry sigmoid and rectum is preferable. When the patient is on the operating table two catheters, number 24 or 26, armed with a small ring at the upper opening (better with opening on the side) and the thread attached to the ring passing through lower opening, are placed in the rectum.

Operation.—In cases of epispadias, with absence of urinary sphincters, lower fistulae and carcinoma of the bladder, the incision is made in the mid-

Fig. 13.—Case of large vesicovaginal fistula, fistula admitting four fingers, where both ureters were transplanted at the same time by the Coffey-Higgins-Brenizer technic. The temperature, pulse and respirations chart and the time of detachment of the necrosing sutures on the Brenizer ring.
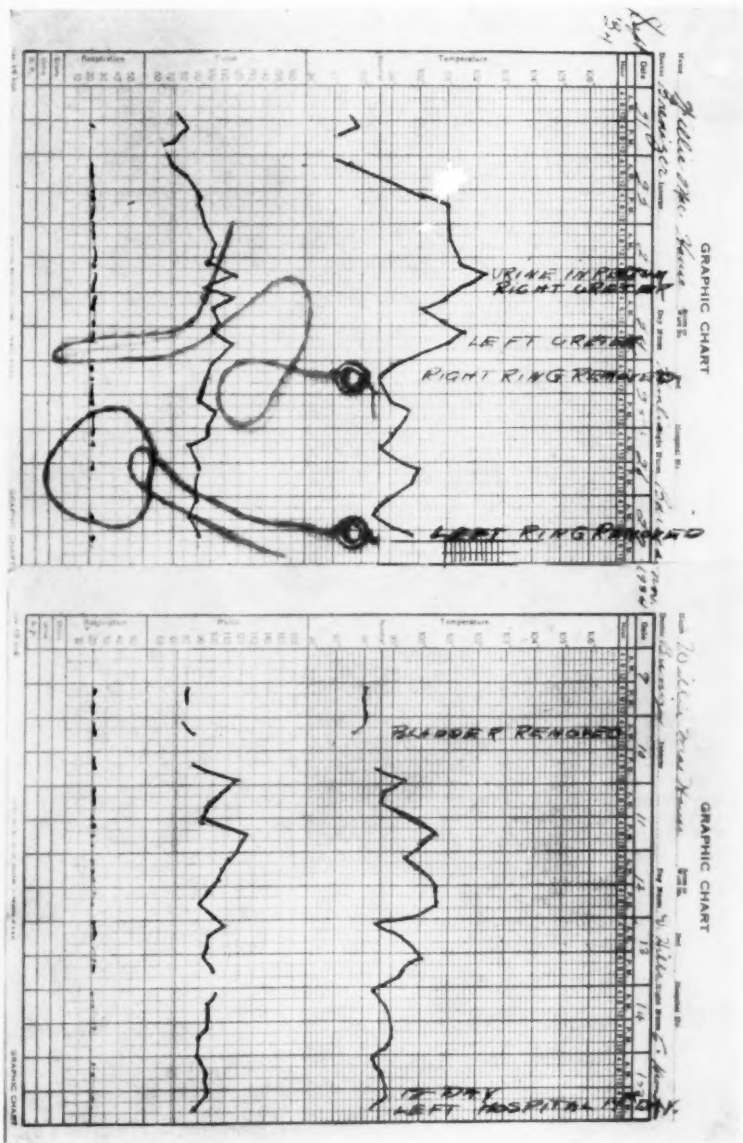
line. The bladder is separated from the peritoneum and around the front and sides, facilitating the future removal at a later stage. If this is done in the female, the bladder can be removed later from below through the vagina. Both ureters are exposed for an extent of two or more inches, as low as possible, in the pelvis and manipulated gently on two blunt hooks.

First, one of the catheters, bearing the ring and thread, is passed up to a high position, higher than the position where it is to be ultimately applied.
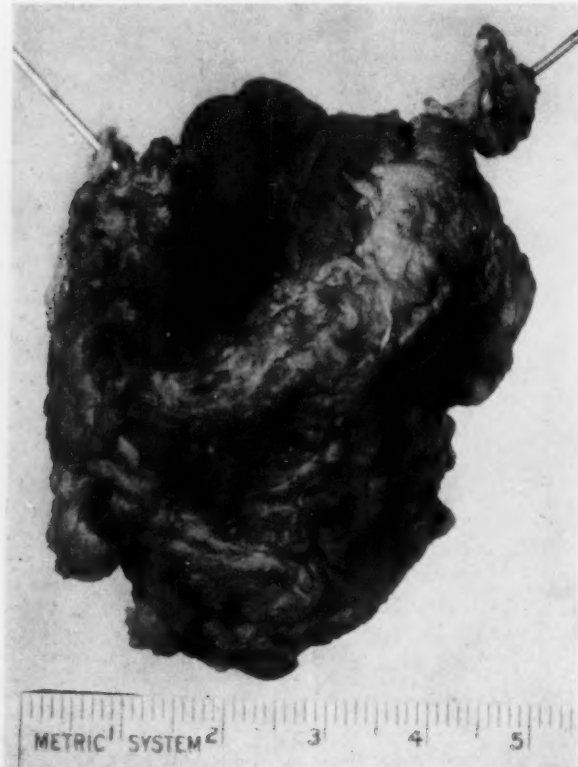
FIG. 14.—Bladder removed from same case as Fig. 13. Note the whole floor of the bladder, a tremendous fistula. Note the bladder ends of the ureters, with probes in them. In this case the ureters were carefully traced back to their emergence from the intestine, on the way to the bladder, severed and the stumps tucked back into the intestine. This step is not necessary when the ureter has been severed by the loop of the hairpin wire already described and, directly, to be portrayed in the following cases.

The catheter is then caught between the fingers and used like a darning egg to cut down upon. The edges of this incision through serosa and muscularis are separated, exposing the mucosa for half an inch in width and two and a half inches in length, which offers an adequate bed and covering for the ureter. The ureter is placed in the bed and may be held there by a suture at upper and lower ends.

The catheter with ring and thread is now pulled down until the ring is in the proper position, i.e., at the junction of the upper two-thirds with the

lower one-third of the incision. At this location the ureter is pierced once or twice with a silk suture and the suture passed through the ring and tied securely.

The catheter is then moved to a slightly lower position, but still well above the lower angle of the incision, and a long hairpin wire is passed over the ureter down the catheter. The muscularis and serosa are closed over the ureter. The same is done with the left ureter at a lower level.

The catheters may be withdrawn or left in place. Preferably, left in place in the rectum, if they stay, or are not uncomfortable. The catheters,

FIG. 15.—Same case as Figs. 13 and 14 after transplantation of both ureters and removal of the bladder. The patient empties her bowel four times a day and occasionally once a night.

ring and thread, and wire can be adjusted from time to time and the ring and thread gently tugged on.

On the fourth to sixth day the ring bearing the necrosing suture comes away and on the tenth to twelfth day the hairpin wire is pulled down upon and the electrocutting current applied to ends of wires. I have demonstrated in the dog that the cutting of the ureters is easily accomplished and effective, that there is very little charring when a low current is used, that there is more or less spreading of the cut ends, and that there is complete, or almost
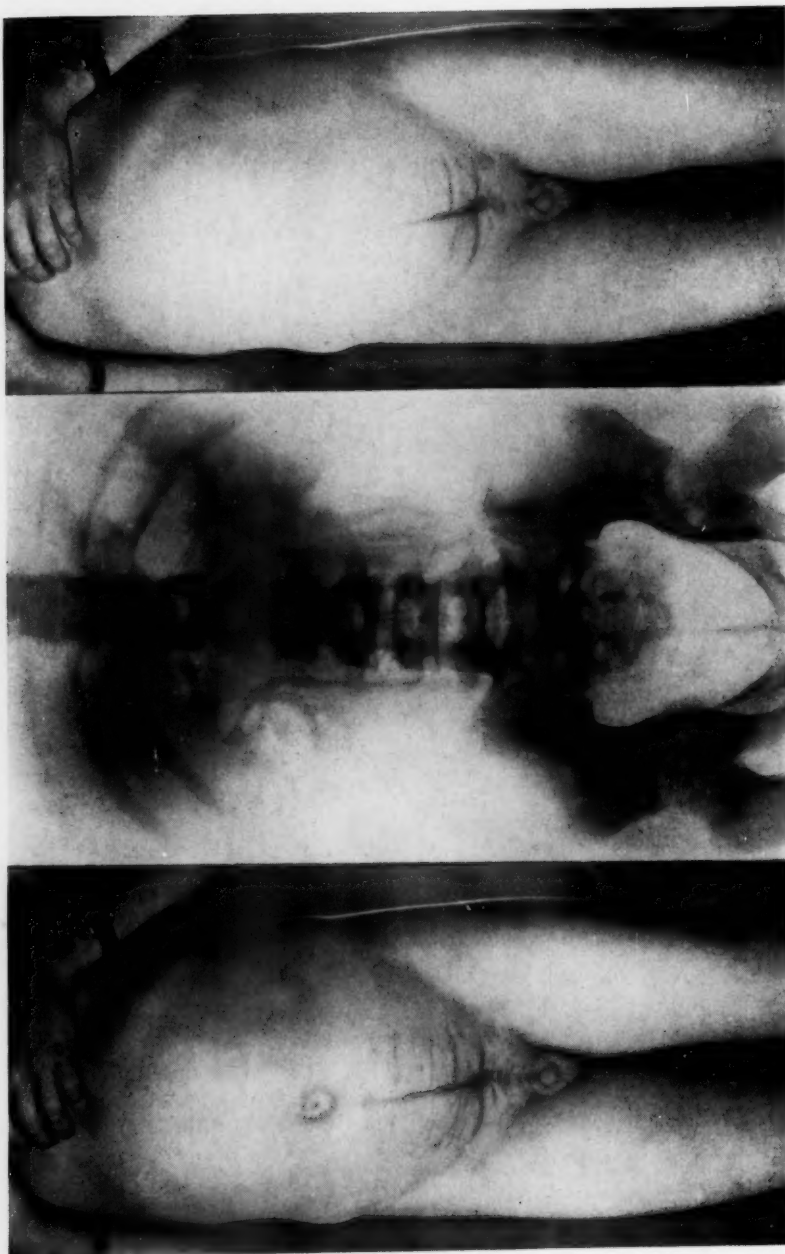
FIG. 16.—Case of epispadias, with incompetent vesical sphincters already having been operated on, when a cystostomy and attempt at repair of urethra was performed, now after transplantation of both ureters at a time by the Brenizer technic.

FIG. 17.—Same case showing the flow of urine after intravenous skiodan.

FIG. 18.—Same case, after removal of bladder and awaiting final plastic on urethra.

complete cessation of escape of urine from the lower portion of the ureters into the bladder.

All of the above steps are preparatory to the secondary operation of cystectomy, which is a comparatively easy procedure with the ureters already severed and both ureterocolonic fistulae having been established by means of the ring and necrosing suture.

The bladder may be removed without particular regard for the portion of the ureter remaining from the point where it has been severed to the bladder. This may be tied off at the bladder, traced back to the intestine and tied off there, or simply avulsed. When the end is closed after merely

FIG. 19.—Case of exstrophy of the bladder in a girl aged 18, after the transplantation of both ureters at the same time, according to the Brenizer technic.

FIG. 20.—Same case showing the flow of urine after intravenous skiodan. Note the nephroptosis on the right side and the hydronephrosis on both sides, somewhat improved, but almost identical with urogram before transplantation. These cases should be operated upon early in life to prevent too large an hydronephrosis. They will probably develop some hydronephrosis, even when operated on.

creating a fistula, the proximal end of the ureter must be embedded in the intestine. The real advantage of this method lies in not having to reopen the peritoneum to embed the distal end of the ureter but merely to tie it off, disregard it or avulse it. In certain cases of fistulae and inoperable carcinoma, the bladder is not removed. When the bladder is removed it is quite a simple procedure to close the dead space in fistulae and carcinoma cases but not in cases of exstrophy where the symphysis is widely separated. In

such instances the structures must be widely dissected out, including a separa-
tion of part of the insertion on the symphysis of the recti-abdominis muscles
and a liberation from their posterior sheaths to make a satisfactory union.
It is never advisable to do a bone plastic with the idea of uniting the separated
symphysis, on account of the encroachment upon the pelvic brim. A possible
consideration is the placing of a bridging bone graft between the separated
portions of the symphysis.

SUMMARY

A technic has been described where a ring on a thread in a catheter was

FIG. 21.—Bladder removed from same case as Figs. 19 and 20. The
bladder may be rather carelessly dissected out, with a knife, electrocoagula-
tion knife preferably, or even with a thermocautery. When the ureters are
reached they are merely tied and cut or only cut and not tucked back into
the intestine. As is well understood, the ureters have already been severed
with the loop over the ureter of the hairpin wire.

conveyed by rectum to a selected site in the rectosigmoid for implantation
of the ureter; the ring is caught with a silk suture which has previously been
passed through the ureter. A hairpin wire is then passed down the catheter,
looping over the lower end of the ureter, piercing the mucosa and on out the
anus.

While it is safer and more secure to first create the fistula with the ring
and necrosing suture and then sever the ureter with the wire, the wire alone,
certainly in the dog, can be used to sever the ureter (electrocutting) or to

gradually necrose through the ureter under traction or to temporarily occlude the ureter for experimental purposes.

At the present time both ring and necrosing suture and wire will be used, but later the single hairpin wire over each ureter may be employed, at the same time, to sever the ureter and thus create the fistula. In this event the operation would again be materially simplified.

FIG. 22.   FIG. 23.

FIG. 22.—Dissection in the same case, showing the removal of the bladder (Fig. 21). The ureters have been severed close to the bladder and the portions running from the rectosigmoid to the bladder have been grasped by forceps. The retractor in the midline indicates the upper angle of the wound. The recti muscles have been widely dissected out and partly cut away from the symphysis. Note that, when other operations are performed, the ureters must be followed into the intestine, the peritoneum opened and the stumps tucked in, to surely prevent a leak and fistula. With the Brenizer technic the ureters have already been severed by the hairpin wire and the burned or necrosed ends are concealed in the intestinal wall. The ureters may be clamped, tied and cut or simply cut and disregarded. Herein lies the great advantage of the Brenizer technic in cystectomy, the ureters may be entirely neglected, the bladder rapidly removed and in fistulous, and certain cancer cases, not removed at all, since there is no visible urine flow.

FIG. 23.—Same case after transplantation of both ureters at a time and then rapid removal of the bladder and immediate closure. It is also evident that after the ureters have been severed by the hairpin wire, there is no more flow of urine to the bladder region, therefore, the region can be thoroughly prepared and cleansed, the bladder rapidly removed and the wound closed.

DISCUSSION.—DR. HENRY L. DOUGLASS (Nashville, Tenn.).—During the last three years, Dr. L. W. Edwards and myself, working in the Surgical Laboratories of Vanderbilt University School of Medicine, have undertaken animal experiments in the field of uretero-intestinal anastomosis. Among our dogs, infection caused such a high postoperative mortality that we became interested in developing an aseptic technic for anastomosing the ureters and the sigmoid, a technic which appears to be similar in certain respects to the method which Doctor Brenizer has just presented.

The first stage of the Ferguson aseptic two stage operative method of ureterocolic transplantation is technically easy to perform. However, this procedure is immediately followed by partial blocking of both ureters, as indi-

cated by an elevation in the non-protein nitrogen of the blood and a decrease in the amount of urine entering and leaving the bladder. We performed the first stage of this operation on 21 dogs. One dog died of rabies on the eighth postoperative day, which was the only fatality. Daily determinations of the N.P.N. content of the blood showed a rapid rise to a peak averaging 100 mg. on the fifth postoperative day, then a gradual decline until a normal level was reached on the fifteenth postoperative day. Subsequently these dogs remained normal in every particular, and we concluded that a few days of partial ureteral obstruction caused as a rule no permanent damage to the parenchyma of the kidney.

The second stage of Ferguson's operation on dogs proved unsuccessful. Attempts to complete the anastomosis by his method were almost universally followed by the death of the animal within four weeks.

At postmortem we always found evidences of ureteral obstruction in the fistula, which had been created between the ureter and the bowel, and secondary infection in hydronephrotic kidneys. Many modifications of this technic were tried, but we were unable to produce, by this method, a fistula which would remain adequate. Furthermore, the later results which followed the use of Coffey's transfixion suture were disappointing.

Our experiments with each of these methods led us to believe that anastomosis by means of a side to side fistula tends to develop subsequent stenosis and obstruction. It seemed to us more desirable, therefore, to have this end of the ureter open directly into the lumen of the bowel. To accomplish this and at the same time preserve the undisputed advantages of Ferguson's first stage operation, we modified that procedure by looping a No. 27 gauge silver wire over the ureter, the limbs of the loop passing through the intestinal mucosa about one-half inch above the lower angle of the incision in the muscularis. The wire is about three feet in length, so that the limbs can be brought well outside the anus. The ends of the wire loop are fastened together with a shot just within the sphincter and the excess wire cut off. We found that one loop over each ureter is sufficient. The muscle layer of the bowel is then closed over each ureter and its encircling loop, and ten days or two weeks allowed to pass before completing the anastomosis.

I called attention to the fact that Ferguson's first stage operation produced, during the first 15 days, a partial ureteral obstruction which later disappeared without causing permanent damage to the kidneys. However, when the first stage is modified by a silver wire looped over the ureter, as previously described, both the degree and the duration of obstruction is increased. During the 10 to 14 day interval which one must allow for healing, before the loop can be removed through the rectum by means of the electric current, marked changes take place in the renal parenchyma, which are permanent and frequently fatal. During this period the N.P.N. of the blood is often observed to reach 200 mg., and, in one instance, 340 mg.

I wish to emphasize, therefore, the importance of draining the renal pelvis with ureteral catheters during the period in which the loops are *in situ*. Just before the operation is begun, the patient should be cystoscoped and a No. 7 ureteral catheter passed to either kidney and left in place. Their presence will in no wise interfere with the operation, and they should not be removed until just before the wire loops are cut out.

During the operation for cancer of the bladder, while the posterior layer of the peritoneum is open on either side, the internal iliac arteries should be ligated. This causes no damage to the pelvic organs, and has the following advantages: It stops the intravesical hemorrhage of cancer; the growth of malignant cells may be temporarily impaired, and direct extension and me-

tastases delayed. Moreover, if the cystectomy is done within 15 days, or before collateral circulation is established, it is almost bloodless and can, therefore, be done in a much shorter time and with less risk to the patient.

Dr. Ellis Fischel (St. Louis, Mo.).—I have grown hot and cold over this subject of ureteral transplantation ever since 1922 when I performed my first and only successful case of total cystectomy for cancer of the bladder. This patient, now 72 years of age, has had both ureters emptying into the rectum for 13 years. Except for nocturnal incontinence, he is comfortable and enjoys average health for a man of his years. I have operated upon eight patients for a similar condition, and the longest postoperative survival has been eight weeks.

At the Barnard Free Skin and Cancer Hospital we hold that only one type of carcinoma of the bladder justifies ureteral transplantation. This is the type in which the base and at least one ureteral orifice is involved in the growth, and in which radiation from radon in gold "seeds" has failed. Therefore, these cases always have dilatation and infection of at least one ureter and are poor surgical risks—so that the problem of ureteral transplantation is much different from that encountered in exstrophy of the bladder or in experimental work on dogs. One, two and three stage operations have been attempted. Coffey's first, second and third methods have been scrupulously followed. I have tried to minimize the infection from the involved ureter by preliminary nephrostomy. The patient went home to recuperate from this operation and died before any direct attack on the ureter could be made. One patient had double ureters from each kidney, necessitating four implantations instead of two. This patient survived long enough for healing to take place and the postmortem specimen afforded interesting material for study. With increasing experience, I feel that the one stage operation is as safe as any, because after removal of the bladder the depths of the pelvis can be better drained. My patients have died from infection, which I feel is always possible either from an infected ureter or from the interior of the bowel, even though the bowel has been entered merely by one stitch. Doctor Brenizer's method for uretero-intestinal anastomosis may have advantages. I hope he will have ample opportunity to demonstrate its repeated success, especially for the sake of that most miserable patient who is afflicted with carcinoma of the base and trigone of the urinary bladder.

Dr. L. W. Edwards (Nashville, Tenn.).—I agree with Doctor Fischel that infection is the main obstacle to successful uretero-intestinal anastomosis. In collaboration with Doctor Douglass we have been working on a method to obtain an aseptic technic for ureterosigmoid anastomosis but have not at this time operated upon a large enough number of cases to justify a clinical report. One case has been operated on in which we used the Ferguson technic of placing the ureters in the bowel wall to obtain a valve effect, but allowing the ureters to continue their course uninterrupted into the bladder. On the tenth day the ureters were cut through by the silver wire, with the cutting current, as described by him. The blood chemistry was done every day for a period of two weeks following the second stage and the kidney function remained apparently normal. Ureteral catheters were left *in situ* during the period of ten days between the first and second stages. At the end of one week following the second operation the patient was in good condition, with normal temperature and normal kidney function, at which time a total cystectomy was done for an extensive carcinoma of the bladder.

During the first operation when the ureters were embedded in the bowel wall both internal iliac arteries were ligated; this facilitated the operative pro-

cedure of total cystectomy by reducing hemorrhage to a minimum. Convalescence was smooth and uninterrupted, and at the present time the patient is perfectly comfortable with satisfactory ureteral drainage.

DR. ADDISON BRENIZER (closing).—If I have failed to demonstrate how very simple this operative technic is it has been on account of my failure to properly express myself, for I hoped to give the impression that it was particularly uncomplicated. It frequently takes two hours for other methods while with the suggested technic both ureters can be transplanted in three-quarters of an hour. It resolves itself into simply placing both ureters in the rectum upon its mucosa. Then take the hairpin wire, slip it over, close the muscularis over it, suture, and the operation is completed. Then with an open ureter with the wire over it, the current is turned on and it is cut.

REFERENCE

[1] Higgins: Aseptic Uretero-Intestinal Anastomosis, in Surg., Gynec., and Obst., September, 1933; Am. Jour. Surg., November, 1933; and Jour. Urol., June, 1934.

STRICTURES OF THE PROSTATICO-MEMBRANOUS URETHRA*

NEWER METHODS IN THE MANAGEMENT OF DIFFICULT LESIONS

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The technical care of strictured conditions in the deep urethra, resulting from traumatism, disease or operation, often presents a serious problem. I wish to bring before you some of the methods that we have employed to combat the difficulties encountered.

CASE REPORTS

Case 1.—*Ruptured Urethra.*—J. M., male, aged 44, admitted September 3, 1931, for relief of impermeable stricture of the posterior urethra. Seven years previously a large generator had fallen upon the patient, from which he sustained a traumatic rupture of the urethra. An immediate operation, supplying suprapubic drainage of the bladder, and perineal drainage of the prostatic region, was performed elsewhere. Many subsequent operations were performed, in attempts to cure the impermeable stricture of the urethra which resulted.

When admitted to Johns Hopkins Hospital the patient had a permanent suprapubic drain. It was impossible to pass any instrument, and a long area of scar tissue, with complete obliteration of the urethra, was discovered at operation, after the excision of which it was possible to carry out an end-to-end anastomosis of the prostate to the membranous urethra. The immediate result was excellent, but after the patient returned home, he failed to secure periodic dilatation of the urethra.

After many months he returned with a very tight stricture of the urethra, through which urine was voided with great difficulty. Examination showed the apex of the prostate and membranous urethra surrounded by much fibrous tissue. In front of this the bulbous urethra was considerably dilated and pocketed, as a result of numerous attempts to pass instruments into the bladder. Catheters and sounds met with a very firm obstruction. Filiforms engaged in something, and may have entered a short distance into the membranous urethra (Fig. 1, No. 1), but buckled two or three times upon themselves.

Reviewing the case, it was evident that two conditions had to be dealt with: (1) The difficulty of engaging and penetrating the urethral lumen of the strictured area, owing to the irregularly dilated urethra immediately in front of the strictured membranous portion; and (2) preventing the filiform from doubling upon itself.

To meet these conditions a tube about one-quarter of an inch in diameter was constructed, which could be passed down into the bulbous portion of the urethra. Inserting a filiform into this we were able, by moving the outer portion of the tube (Fig. 1, No. 2), to bring the point of the filiform to various places in the indurated mass, in which lay the lumen of the membranous urethra. Finally, by depressing the outer portion, and thus searching the superior surface of the urethra, the lumen was engaged by the filiform (Fig. 1, No. 3), which, without much difficulty, passed through the prostatic urethra into the bladder. The small tube had effectively prevented the filiform doubling back upon itself. Removing the tube, a curved steel following sound (LeFort) was at-

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* Read before the Forty-sixth Annual Meeting of the American Association of Genito-Urinary Surgeons, Hot Springs, Va., May 14, 1934.

tached to the filiform and pushed on into the urethra. It was then discovered that the filiform had again doubled upon itself, thus making it impossible to carry the sound through the strictured urethra. The follower was removed, the tube reinserted, and a flexible bougie follower (Fig. 1, No. 3) was attached to the filiform, which was small enough to pass down the tube. No difficulty was then experienced in pushing this flexible bougie, led by the filiform, through the strictured area into the bladder. The tube had effectively prevented the filiform from buckling.
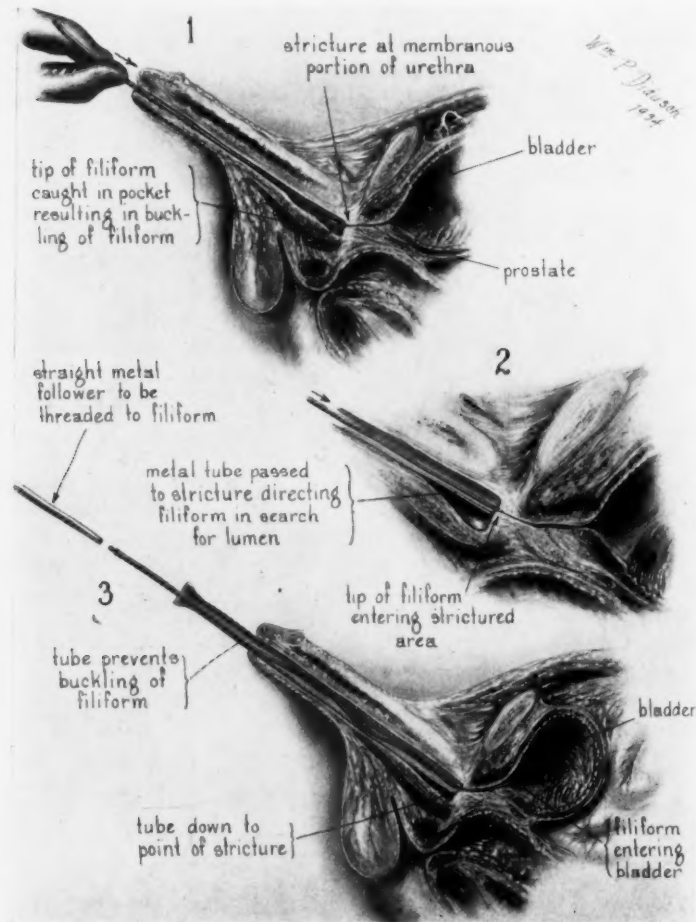
FIG. 1.—Case 1. (1)—Conditions present in a case of pronounced stricture of the anterior, prostatic and membranous urethra after operation for rupture of the urethra. The urethral lumen in the strictured area was small and eccentric. The tip of the filiform engaged in a pouch near the floor of the urethra and the filiform doubled upon itself, as shown. (2)—Use of Young's urethral tube to assist the filiform in searching for the lumen of the urethra, which was finally engaged. (3)—Use of urethral tube to prevent buckling of the filiform while the attached bougie is passed down the tube.

Having thus succeeded in introducing a No. 12 flexible follower bougie into the bladder, a series of tubes were then made (Fig. 2). These varied from No. 16F to 28F in size. Filiforms were first tried alone, but they again doubled upon themselves, and it was impossible to determine whether they had actually entered the strictured urethra or simply engaged in some pouch or false passage in the bulbous urethra. By means of the small tube, which had previously been employed, the proper orifice was

located, the filiform passed into the bladder, followed by a flexible bougie, which was withdrawn, unscrewed from the filiform, the tube removed, a larger one inserted, and another bougie of greater caliber successfully passed through the strictured urethra into the bladder. Using this method at intervals of two to three days, it was soon possible to dilate the urethra up to about No. 20F by means of flexible bougies. When a larger, flexible bougie was used, too great resistance was encountered to force it through the strictured area. Accordingly, metal bougies, without a curve, were made (Fig. 3), which were practically identical with the flexible bougies. One of these instruments, when attached to the filiform (Fig. 1, No. 3), passed easily down an urethral
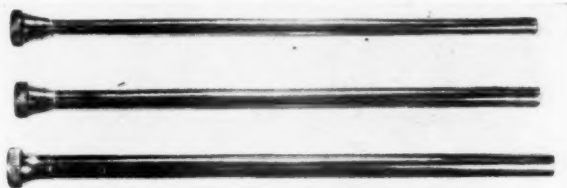

FIG. 2.—Young's urethral tubes to guide filiforms through strictured lumina and prevent buckling of filiforms.

tube until the filiform had gone entirely through the bulbous urethra (Fig. 4, No. 2). The urethral tube was then removed, and the straight metal bougie carried through the strictured area into the bladder (Fig. 4, No. 3). The fact that it was straight seemed to make no difference, the filiform itself furnishing the necessary curve to lead it over the median portion of the prostate into the bladder. In the subsequent treatment of this case, these straight metal bougies were successfully used up to No. 26F, and, although the fibrous mass in the perineum was very resistant, no great difficulty was encountered in pushing them on into the bladder. The filiform was in no case bent

FIG. 3.—Young's straight metal followers attachable to filiforms, and used with or without the urethral tubes to dilate difficult strictures of the anterior urethra, and also very bad strictures of the prostatico-membranous urethra. These followers are now made with the outer end conical, without a screw hole for use without filiforms, particularly after hypospadias operations.

or broken. We are confident that the force employed was exercised with much greater safety than could have been used with the curved metal follower. The use of cystoscopes, urethroscopes and instruments for resection has taught us that it does not require much, if any curve, to go into the bladder. We have long been of the opinion that there was danger in the use of the markedly curved metal dilators, which we have employed in the past.

Owing to the roughened condition of the strictured area, and the greatly dilated bulbous urethra, it was never possible to do without the tubes, which were necessary to prevent the buckling of the delicate filiform.

Case 2.—A severe stricture of the membranous urethra was present, which followed a double sphincter plastic operation for the cure of incontinence. Filiforms engaged, but would not pass, forming several loops in the capacious bulbous urethra. During these manipulations, it was thought at one time the filiform had gone well through into the bladder, and the steel dilating follower was attached. As it would go no farther, it was withdrawn and it was then found that the filiform had broken. Bleeding indi-
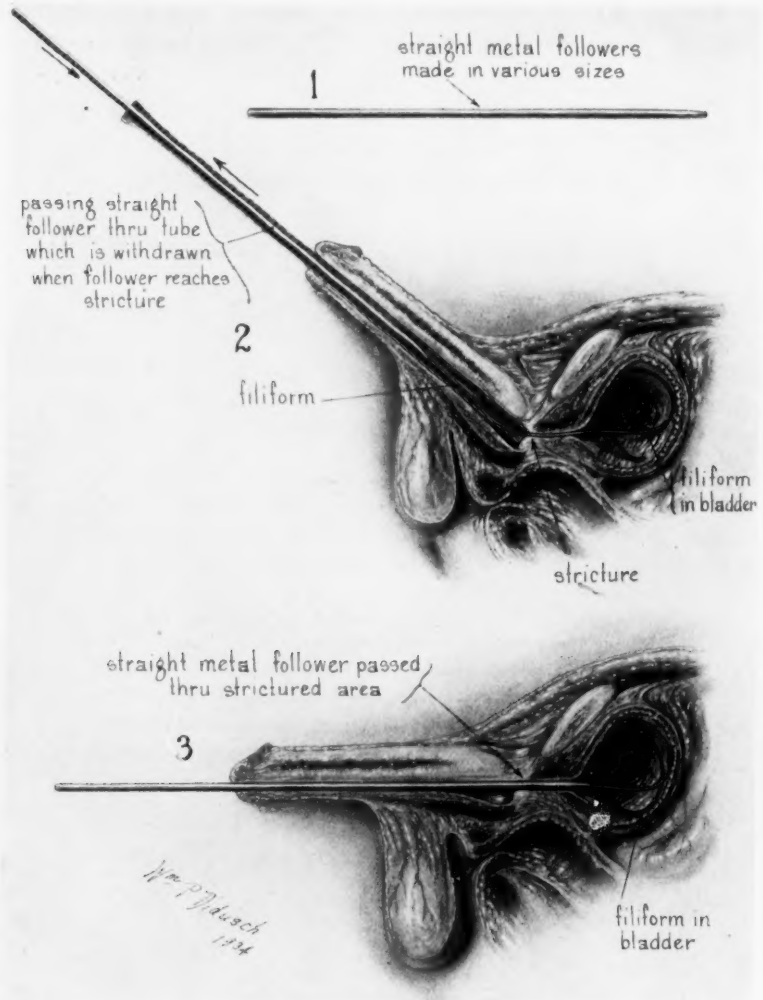
FIG. 4.—Case 1. (1)—Young's metal followers. (2)—The metal tube is being used to prevent buckling of filiform, but is removed when the follower reaches the stricture, in order to facilitate the deeper passage of the follower. (3)—Follower passed through stricture.

cated that the urethra had been traumatized, producing a pouch, or small passage, as a result of the doubling of the filiform. After a few days the urethral tubes shown in Fig. 3 were again used. No difficulty was experienced in finally discovering the orifice through which the filiform passed easily into the bladder, supported as it was by the tube which prevented its doubling. Dilating bougies, which were attached to the filiform, were also passed in this case with increasingly larger tubes to prevent doubling of

the filiform, and little difficulty was experienced in bringing the urethra practically to normal size by the use of this technic. After a time the strictured urethra became so much softer that filiforms and ordinary metal followers could be employed, and ultimately sounds passed consecutively at intervals during the succeeding months. As a result of this treatment, it was possible eventually to dispense with dilatations. The patient had a normally functioning urethra, and was cured of his incontinence.

In such cases it is important not to proceed too rapidly. To cure these patients one must excise all except a small portion of mucosa in order to draw the periurethral muscle (sphincter) into tight contact after excising
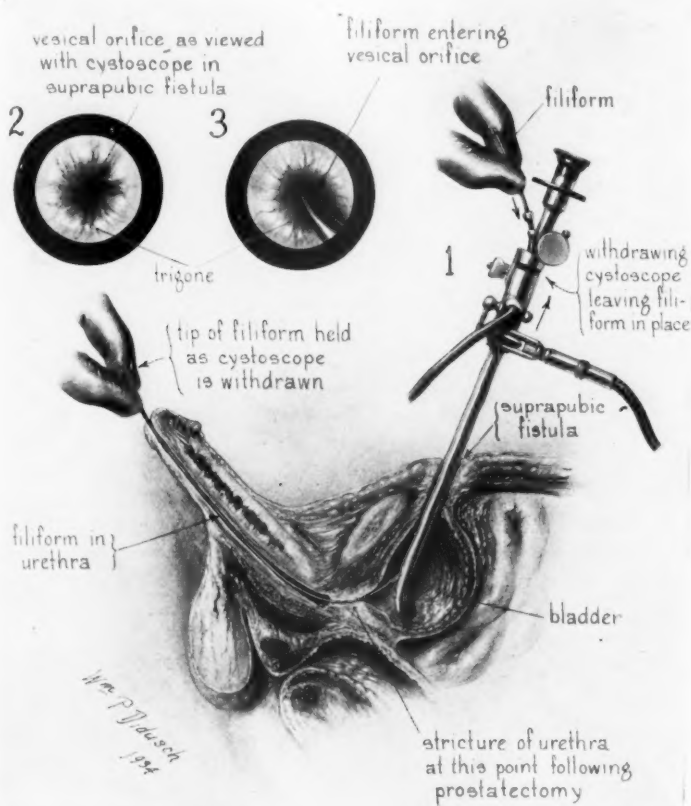
Fig. 5.—Retrograde passage of filiform through catheterizing cystoscope passed into bladder through suprapubic fistula.

the scar tissue (remaining after transurethral resection, or an improperly performed perineal or suprapubic prostatectomy). In other words, it is necessary to produce a stricture to cure the patient. This must be very cautiously dilated to avoid a rupture, which would impair the newly made sphincter.

The set of urethral tubes, above described, has been used successfully now in various types of cases, particularly those in which strictures were deep seated, eccentric, or surrounded by pockets in which filiforms would engage. Support given the delicate filiforms by the tubes effectively prevents doubling

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of the filiform, both during the passage through the stricture into the bladder, and subsequently while conducting a follower to the deep urethra and through the sphincter. Judging by our experience, these tubes should prove a valuable addition to the armamentarium of stricture therapy.
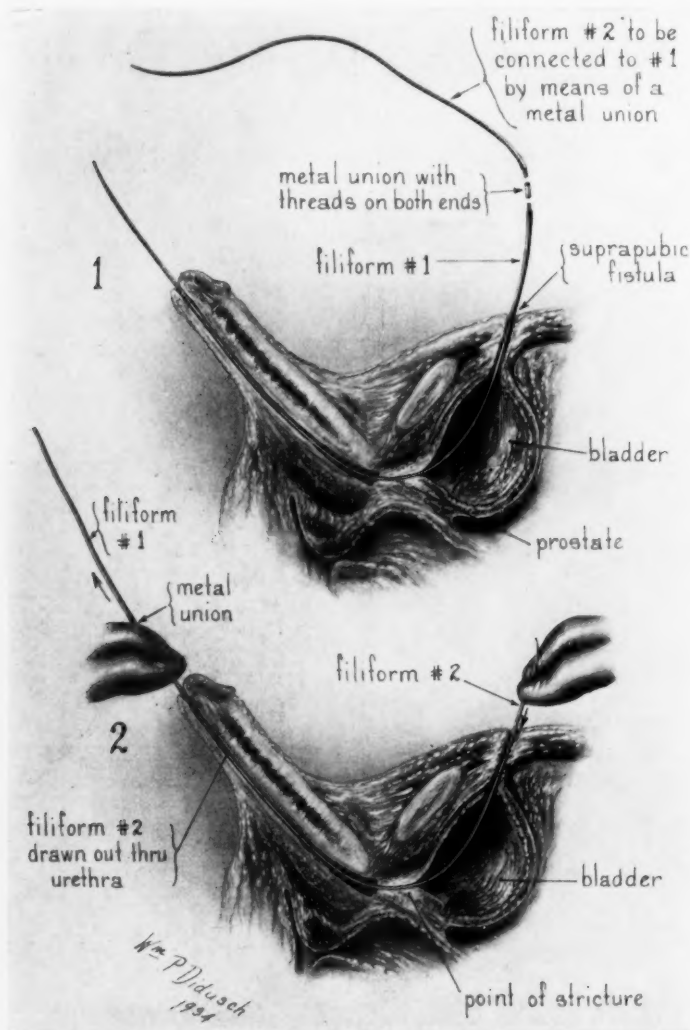
FIG. 6.—(1)—A second filiform is being attached to the one that has been introduced through the suprapubic fistula out through the urethra by means of a metal coupler. (2)—The second filiform is drawn out through the fistula and urethra until the butt end appears at the meatus, when it is detached from the first filiform.

THE USE OF THE CYSTOSCOPE TO PASS INSTRUMENTS, RETROGRADE, FROM THE BLADDER THROUGH STRICTURES OF THE PROSTATIC OR MEMBRANOUS URETHRA

In cases that have been subjected to operations upon the membranous or prostatic urethra (operations for rupture of the urethra, double sphincter

operations for incontinence, epispadias with incontinence, *etc.*) before devising the urethral tubes above described, we occasionally made use of a cystoscope introduced through the suprapubic wound (Fig. 5, No. 1), to pass filiforms through the strictured urethra. In such a case we have usually employed a filiform with a ureter catheterizing cystoscope. After locating the urethral orifice (Fig. 5, No. 2) no difficulty was experienced in passing the filiform into the prostatic urethra (Fig. 5, No. 3) and in the majority of cases it would also pass retrograde on through the strictured area and out the meatus, where its point was caught by an assistant. Withdrawing the cystoscope, and catching the screw end, which projects a short distance
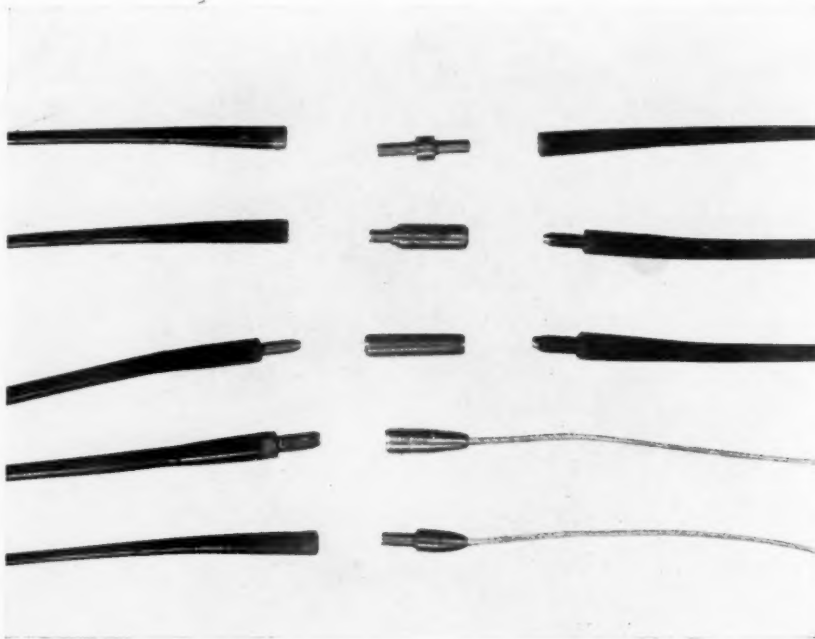
FIG. 7.—Various filiforms and different types of couplers necessary to connect them. In two lower photographs, a coupler attaching a thread or silkworm gut to filiform is shown.

from the suprapubic fistula, one was confronted then with the problem of passing dilating followers through the strictured area. By screwing a dilating bougie onto the filiform, and making traction upon it, the dilator was pulled and pushed through the suprapubic wound, and the strictured area out to the meatus. No metal instrument could be used for this.

At other times retrograde passage of a dilating bougie is not satisfactory, as not enough pressure can be exerted upon the flexible bougie. It is then desirable to attach another filiform to the one passed retrograde, thus fastening the butt ends together (Fig. 6, No. 1) by means of a coupling tube, so that the second filiform can be drawn out until its screw end projects from the meatus. The operator is careful to hold onto the pointed end, so as to prevent its escaping into the bladder (Fig. 6, No. 2). Dilating fol-

lowers are then attached to the filiform, and, by combined pushing and traction, are carried through the strictured area one after another until sufficient dilatation is accomplished. In our armamentarium are dilators which carry various types of filiforms (some male, some female, some with small and others with a large thread) so that in practice it has been found necessary to have screw couplers, with which every type of filiform can be attached to
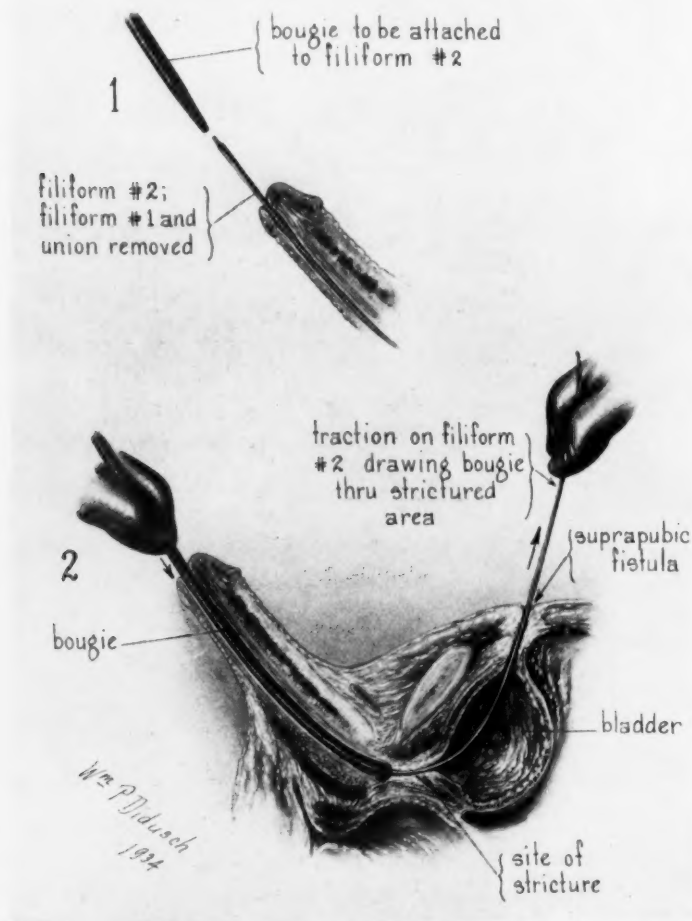
FIG. 8.—(1)—Flexible bougie is being attached to the second filiform, which has been drawn through the suprapubic fistula. (2)—Method of passing the flexible bougie by combined traction and pushing.

every other one. Some of these combinations are depicted in Figs. 7 and 8. With these simple screw couplers, no difficulty is experienced in passing filiforms and followers of various types through the urethra and out of suprapubic drainage fistulae (Fig. 8).

The use of the cystoscope to pass filiforms retrograde through a stricture in the urethra is troublesome, difficult and occasionally unsatisfactory. It is,

therefore, desirable, when one has succeeded in passing filiforms to dilate
strictures, to leave a thread in the urethra to avoid having to employ the
cystoscope at the next treatment. This thread must be drawn through the
urethra by the filiform when it is removed. To accomplish this, we have
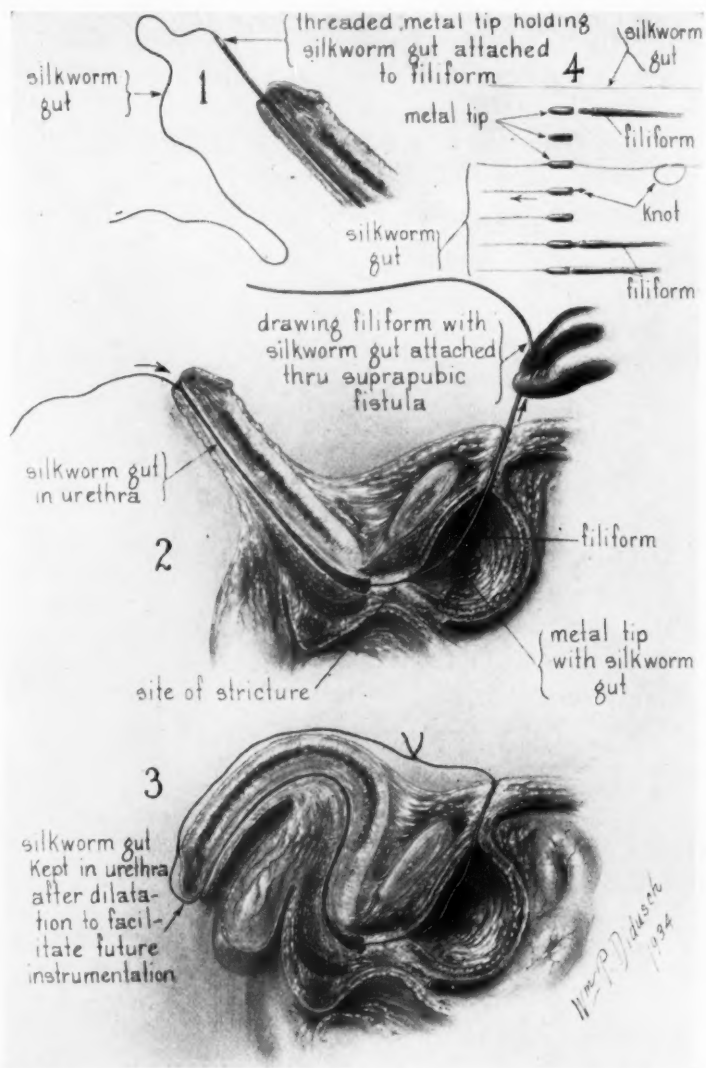
FIG. 9.—(1)—Attaching thread to filiform by conical coupler. (2)—Draw-
ing thread through urethra, bladder and suprapubic fistula. (3)—Silk thread
or silkworm gut left in place to facilitate passage of filiform next time. (4)—
Method of attaching silkworm gut to conical coupler and then coupler to filiform.

had made a conical connecting piece through which the thread may be passed,
knotted, attached to the filiform (Fig. 9, No. 1) and then drawn through
the meatus and out the suprapubic fistula by the filiform (Fig. 9, No. 2).
The urethral and vesical ends are then tied together so as to prevent escape
(Fig. 9, No. 3). Braided silk threads are usually employed, but as these

have a tendency to accumulate calcareous deposits, we have more recently used a silkworm gut, which has no such drawback. In order to attach the silkworm gut, it is simply introduced through the coupling piece, bent firmly together, pulled out until a small loop remains, a bit of loose cotton placed in the loop to prevent its being drawn through when traction is made. By this method (Fig. 9, No. 4), silkworm gut can be used to draw filiforms through the strictured urethra for subsequent dilatations. A knot can also be used.

POSTOPERATIVE URETHRAL DILATATIONS

We now, after plastic operations in which dilatations must soon be carried out, leave a fine thread of silkworm gut in place. It remains there
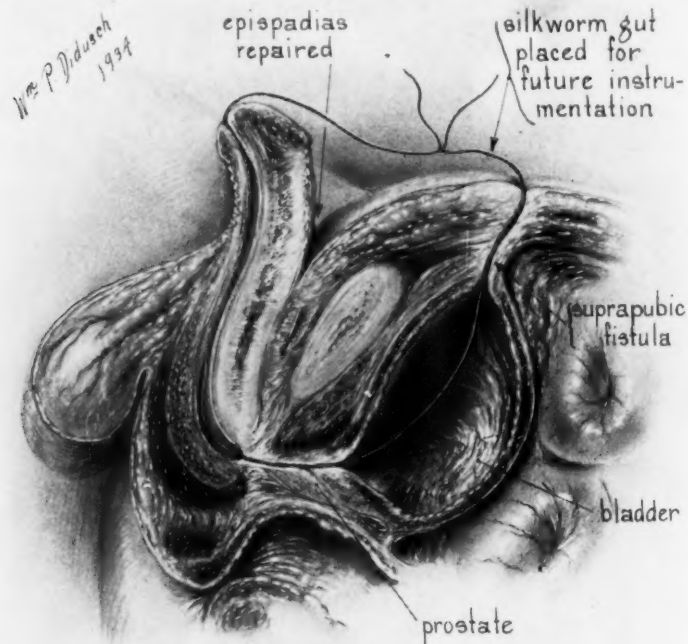
FIG. 10.—Suture still in place after withdrawing suprapubic drainage tube in a case of Young's double sphincter and penile plastic operation for epispadias.

until some three to four weeks after the operation, when the first dilatations with filiforms and bougies are to be undertaken. Fig. 10 shows a case of epispadias with incontinence, in which a double sphincter and penile plastic operation was carried out. The silkworm gut left in place emerges from the meatus and from the suprapubic wound. Some three to four weeks later it is employed to draw a filiform through, and this is followed by gradual dilatations with flexible bougies, and, in some cases, metal dilators. The same method is employed in the double sphincter operation for incontinence,

after transurethral resection, or prostatectomy. In cases of hypospadias, the passage of filiforms and followers after the operation may often be the cause of serious injury and breakdown of the sutured wound. By leaving a silkworm gut in the newly made urethra (Fig. 11), one end emerging from the perineal wound, and the other from the newly made meatus in the glans, several dilatations with filiforms and small followers can be ultimately carried out without danger or difficulty.
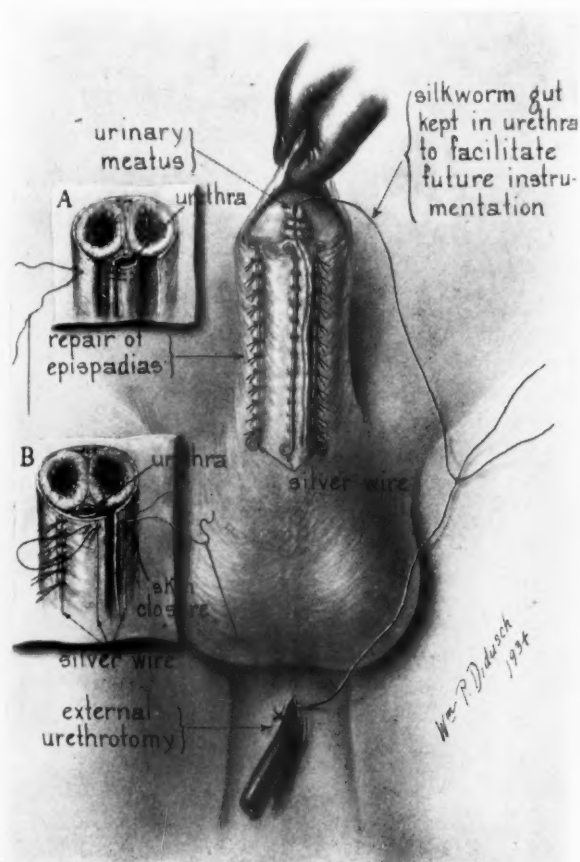
FIG. 11.—Thread left in place after completion of hypospadias operation by latest technic with use of silver wires: (A)—formation of urethral tube; (B)—covering urethral tube with penile skin (overlapping method).

CONCLUSIONS

Not infrequently after various operations upon the urethra, necessitated by traumatisms, inflammatory strictures, incontinence or congenital defects (epispadias, hypospadias, *etc.*) one must pass dilating instruments. The passage of filiforms through the dense stricture is often extremely difficult, particularly as they have a tendency to buckle upon themselves and prevent the passage of a dilator; in fact, the attempt to pass a dilator may often

lead to severe traumatism, the operator not realizing that the filiform has buckled or broken. New instruments and technical methods have been described to obviate these difficulties, first a series of urethral tubes which facilitate the discovery of the urethral lumen in the strictured area, and which also prevent the buckling of the filiform when it and the attached, dilating follower are passed. The use of the catheterizing cystoscope to dilate a stricture of the deep urethra, by passing filiforms retrograde, has been described, and various technical devices for joining one filiform to another, or to attach a silk thread or silkworm gut, which is to be left in place to conduct other filiforms through the strictured region at subsequent treatments, have been depicted. By means of these simple mechanical devices, the postoperative care of various urologic operations has been rendered much more accurate and satisfactory.

RECTAL STRICTURE DUE TO LYMPHOPATHIA VENEREUM*

A CLINICAL AND PATHOLOGIC STUDY OF SIX CASES OBSERVED AT NECROPSY

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THE application of the Frei test to cases of so called anorectal syphiloma by Frei and Koppel[1] in 1928 altered the ideas previously held on the subject of inflammatory rectal stricture. Prior to that time syphilis, gonorrhea and tuberculosis were universally believed to be the principal etiologic factors. Since then a considerable amount of clinical and experimental evidence has been collected to prove that lymphopathia venereum is responsible for a large majority of these cases, and an entirely new concept of stricture of the rectum has therefore arisen.

The evidence just referred to has recently been reviewed[2] in a report from Charity Hospital in New Orleans of 154 Frei-positive cases of lymphopathia venereum, including a detailed analysis of 58 cases of rectal stricture. New Orleans appears to be a veritable hotbed of the disease, being a seaport with a large Negro population. The number of patients admitted with inflammatory rectal stricture, the most frequent manifestation of lymphopathia venereum in the female, exceeds 100 in the course of a year. During the period 1911–1933, inclusive, 1,285 cases of rectal stricture were treated at Charity Hospital, not more than 10 per cent of which were obviously postoperative or neoplastic, and it seems safe to assume from the clinical data that the great majority of the remaining cases fall into the group under discussion. According to our evidence, rectal stricture accounts for approximately 70 per cent of the cases of lymphopathia venereum in women, whereas pudendal lesions and inguinal buboes together constitute not more than 25 per cent of the lesions in this sex. In a consecutive series of 83 Frei-positive tests in females recently reported,[2] eight cases exhibited inguinal buboes and 12 esthiomène or chronic elephantiasis of the vulva, whereas 57 had rectal stricture. Also included in this group were two patients with anal granuloma without stricture, two with granulomatous proctitis without stricture, and two with granulomatous lesions of the cervix uteri.

The type of inflammatory stricture due to lymphopathia venereum has been known to surgeons and dermatologists since its description by the Danish surgeon, Larsen,[3] in 1849 as "hyperplastic infiltration of the rectum," and by Fournier[4] in 1875 as "anorectal syphiloma." A comprehensive review of the subject may be found in the recent monograph of Stannus.[5]

The frequent involvement of the rectum by the virus of lymphopathia venereum is readily explained by the lymphatic drainage of the genitalia in the female, as demonstrated by Jersild,[6] Barthels and Biberstein.[7] As these

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* The term lymphopathia venereum has been substituted for lymphogranuloma inguinale, in accordance with the newly adopted nomenclature.

investigators have emphasized, only a small proportion of the primary lesions in the female, those situated on the external labia or the clitoris, drain to the inguinal lymph nodes, in contradistinction to the male group, in which inguinal buboes are the rule. In the occasional instances of rectal stricture observed in male patients, either colored or white, a history may often be elicited of a primary anal lesion, following pederasty.

We have had the unusual opportunity during the past year of observing at necropsy six cases of rectal stricture, in three of which Frei-positive reactions were obtained during life.

FIG. 1.—Necropsy specimen (Case 1). Chronic ulcerative stenosing proctitis and periproctitis in rectal stricture of two to three years' duration, with positive Frei reaction.

CASE REPORTS

Case 1.—S. R., a Negro female, aged 30, had a history of rectal stricture and proctitis of at least two years' duration. For the last eight months she had complained of amenorrhea, a purulent discharge from the rectum, increasingly difficult bowel movements, and pain in both inguinal regions. Physical examination revealed a bulging mass in the anterior rectal wall, with ulceration of the rectal mucosa and draining sinuses

about the anus. The Wassermann reaction had been positive a year before admission, but was negative after treatment. The Frei test was positive. The clinical diagnosis was rectal stricture (lymphopathia venereum) with multiple fistulae in ano and hemorrhoids. Routine treatment was undertaken but the patient did not respond and died three months after admission.

Necropsy revealed a chronic ulcerative stenosing proctitis and periproctitis (Fig. 1). The cause of death was a superimposed acute ulcerative colitis involving principally the descending colon and sigmoid, with terminal cardiac failure.

The relevant portion of the protocol follows: The lowermost portion of the rectum, extending up from the anus about a finger's length, approximately 10 to 12 cm., is considerably thickened and indurated. The mucosa shows numerous small granulomatous tags, as well as several incomplete fistulae, and has an irregular, band-like, ribbed or corrugated appearance. This lesion ends abruptly in a stenosing, shelf-like formation which sharply demarcates the granulomatous tissue from the relatively uninvolved
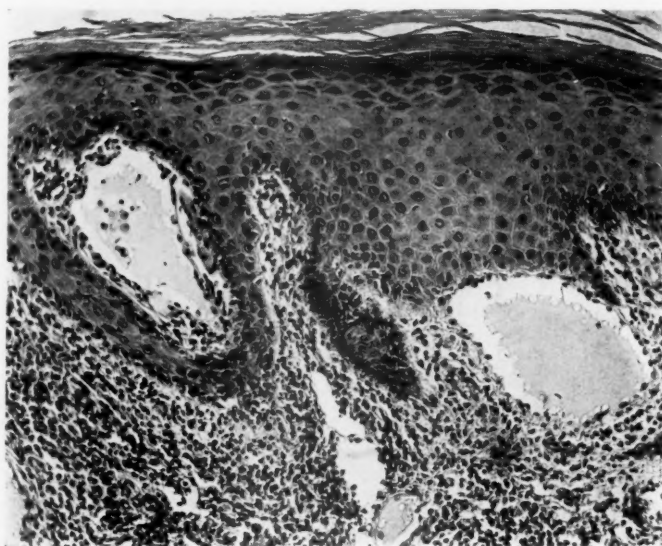
FIG. 2.—Section of anal tag simulating hemorrhoid in case of rectal stricture. Note keratosis, chronic inflammation and numerous dilated lymphatics.

sigmoid above it. At the anus are several small fleshy or rubbery tags, varying in size from 1 to 3 cm. in diameter, and the adjacent perianal region shows several small areas of dimpling and scarring indicative of fistulae in ano.

Microscopic examination of the rectum shows the wall markedly thickened. The mucosa is ulcerated and infiltrated with small round cells, polymorphonuclear leukocytes, plasma cells, and histiocytes. There is a tendency to regeneration of the mucosa, with squamous metaplasia. The thickened submucosa shows a loose vascular connective tissue with areas of hyalinization and many tissue spaces, some of which are lined by a single layer of endothelial cells and have the appearance of dilated lymphatics. The muscularis is distinctly hypertrophied and presents extensive infiltration with nests of small round cells. The thickened and adherent perirectal fat and connective tissue show infiltration with small lymphocytes and plasma cells, fibroblastic proliferation, fibrosis and endarteritis with narrowing. Sections of the perirectal lymph nodes in the vicinity of the stricture present periadenitis and chronic nonspecific lymphadenitis, characterized by fibrosis and plasma cell infiltration. Section of an anal tag (Fig. 2) shows parakeratosis, keratosis, fibrosis of the corium and subcutaneous tissue, and, in places, a loose,

edematous granulation tissue extensively infiltrated by plasma cells. Numerous dilated lymphatics are also in evidence.

White mice were inoculated with infected tissue emulsion prepared from fragments of the rectal mucosa, regional lymph nodes and fistulous tracts. The mice injected intraperitoneally showed no evidence of infection, while those inoculated intracerebrally developed suppurative meningitis.

Case 2.—J. A., a Negro female, aged 37, had received hospital treatment seven years previously for the rectal stricture which she presented on admission. She had cardiac decompensation at this time, and was incontinent and psychotic. Physical examination revealed a rectal stricture admitting one finger, a rectovaginal fistula, anal tags, and several fistulae in ano. The labia were markedly enlarged and indurated. There were draining sinuses in both inguinal regions and deep, infected decubitus ulcers over the sacrum. The Wassermann reaction was positive and the Frei test negative.* The patient was in extremis when observed and died several days later of cardiac failure.

Anatomic Diagnosis.—Chronic stenosing proctitis and periproctitis with multiple fistulae; chronic ulcerative vulvitis and vaginitis with secondary infection; rectovaginal fistula; multiple infected decubitus ulcers over the sacrum; dilatation of the heart; pulmonary congestion and edema; anasarca; severe fatty change of the myocardium and liver; chronic and acute infectious splenic swelling; luetic mesaortitis with saccular dilatation of the ascending arch.

The relevant portion of the protocol follows: The loop of terminal ileum just proximal to the ileocecal junction is adherent to an inflammatory mass about the sigmoid, and communicates with the latter by a fistulous opening. At this site, there are also several fistulae of the sigmoid leading into the surrounding inflammatory tissue. In the ascending colon there is an oval, shallow ulcer, with a red, sharp border, measuring about 2 cm. in diameter. The remainder of the bowel shows nothing significant except for the sigmoid and rectum, which are the site of a peculiar granulomatous stenosing lesion, approximately 45 cm. in length. The thickened rectal mucosa shows tag-like, edematous papillary excrescences. The indurated wall of the rectum and sigmoid is surrounded by a thick mass of inflammatory fat and connective tissue, into which multiple fistulae extend from the mucosa. There is an area of constriction in the sigmoid, several centimeters above the rectosigmoid junction. There is another area of stenosis in the lowermost portion of the rectum, where the lumen is narrowed for a distance of approximately 10 cm.

The vulva is diffusely thickened and enlarged. The clitoris, the pudenda and the perirectal tissue show induration, multiple granulomatous tags, and secondary infection with ulceration. About 2 cm. from the vaginal orifice there is a large rectovaginal fistula. The vaginal fornix shows a shallow, ulcerated area about 2 cm. in width. There is also a small, red, ulcerated lesion on the cervix about 0.5 cm. in diameter. The uterus shows no significant change, but the adnexa are buried in dense pelvic adhesions.

Histologic sections show extensive secondary infection and postmortem change, but it is evident that the chronic inflammation in the rectum, sigmoid, vulva, vagina, and other structures is nonspecific in character. No plasma cell reaction is noted, nor any endarteritis or endophlebitis suggestive of luetic granuloma. The tissues were obtained too long after death to permit of animal inoculation.

Case 3.—C. M., a Negro female, aged 29 years, was admitted with a diagnosis of pulmonary phthisis and hypertensive heart disease, the diagnosis being based on the history of productive cough, loss of weight, dyspnea and edema of the ankles of two to three months' duration. She appeared acutely ill; the temperature was 101° F., and

* It is pertinent in connection with this case to cite the reminder of Cole, that in certain instances of prolonged illness and lessened general resistance, there may be an allergy, and his warning that in such cases lymphopathia venereum should not be ruled out on the basis of a single negative Frei reaction.

signs of focal consolidation were elicited in the right chest. Pelvic examination revealed a profuse vaginal discharge and adnexal tenderness. Because of the patient's serious condition, rectal examination was not made and the correct diagnosis was therefore not suspected until autopsy. Death occurred two days after admission.

Anatomic Diagnosis.—Chronic ulcerative stenosing proctitis and sigmoiditis with ileosigmoidal fistula; acute diffuse fibrinopurulent peritonitis; bronchopneumonia with serofibrinous pleuritis; luetic mesaortitis. The cause of death was peritonitis, probably
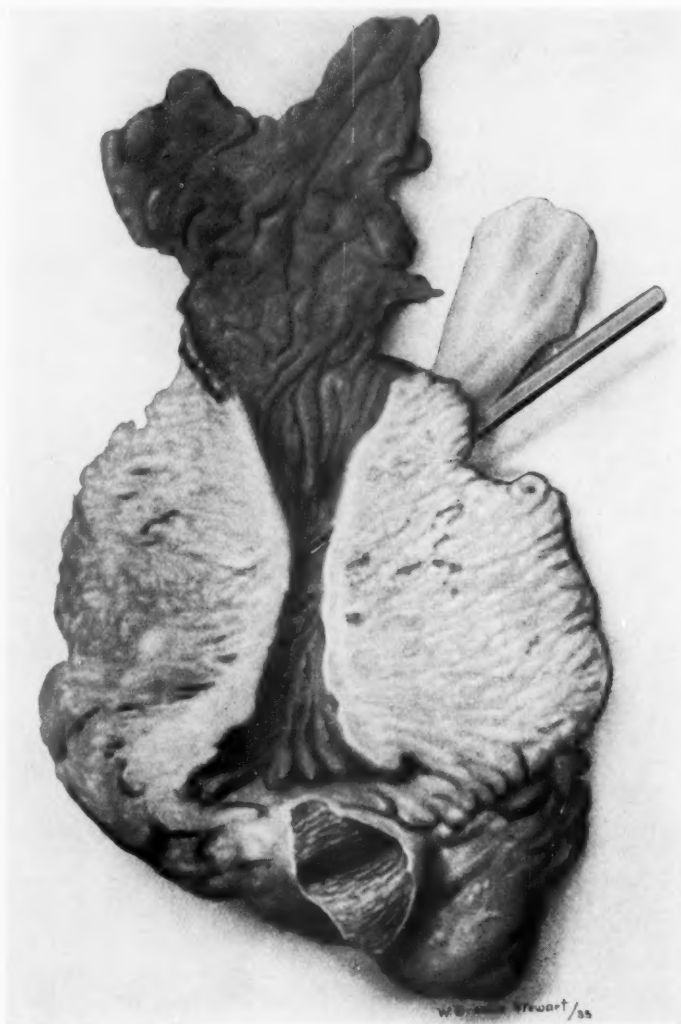
Fig. 3.—Necropsy specimen (Case 3). Chronic ulcerative stenosing proctitis and sigmoiditis with ileosigmoidal fistula.

due to perforation of the sigmoid, and it was inferred that the walling off of the perforation by a loop of ileum had resulted in an ileosigmoidal fistula. The lesion in the rectum and sigmoid is well illustrated in Fig. 3. The histologic study was unsatisfactory because of postmortem change, and the material was too old for animal inoculation.

Case 4.—B. S., a Negro female, 29 years old, had been seized with upper abdominal pain, preceded by dizziness and syncope, six days before admission. The pain, together

with distention and tenderness, had persisted since that time, and bowel movements had been scanty in spite of the free administration of purgatives. Persistent vomiting had developed, and the whole story was compatible with the admission diagnosis of rectal stricture, with intestinal perforation and low-grade peritonitis. Rectal examination showed a stricture approximately 3 cm. above the anal orifice, barely admitting the tip of the little finger. Roentgenologic examination of the abdomen revealed numerous fluid levels and air under the right leaf of the diaphragm. The patient's condition did not warrant surgical intervention, and death occurred on the fourth day after admission.

Anatomic Diagnosis.—Chronic ulcerative granulomatous proctitis with marked stenosis; rectovaginal fistula and multiple fistulae in ano; ulcers of the sigmoid with perforation and diffuse peritonitis.

The relevant portion of the protocol follows: The peritoneal cavity contains a large amount of yellowish, purulent fluid and fecal material. The descending colon and sigmoid are distended, hypertrophied, and filled with stone-like fecal masses. A small area of perforation in the sigmoid has allowed the entrance of fecal material into the peritoneal cavity. The hypertrophied mucous membrane at this site shows multiple deep ulcers due to pressure by impacted fecal masses. The rectum is distended and the wall of the ampulla is markedly thickened and indurated. Three centimeters above the anus there is a narrowing of the rectal lumen with marked fibrosis of the perirectal tissue. The mucous membrane of the rectum shows scar formation and several fistulae which extend into the perirectal fat tissue. At this site there is also a large rectovaginal fistula. The gross specimen is illustrated in Fig. 4. The histologic study was unsatisfactory because of postmortem change, and for the same reason animal experiments were not undertaken.

Case 5.—H. N., a Negro female, aged 29 years, sought hospitalization for the treatment of fistulae in ano and pellagra. She complained of a burning tongue, diarrhea, and discoloration and itching of the hands, all the symptoms being of three months' duration. Physical examination revealed a rectal stricture 4 cm. above the anus, barely admitting the index finger, together with "hemorrhoids" (anal tags) and induration of the rectovaginal septum. The rectum below the stricture was irregularly thickened. The temperature ranged to 102° F. Both the Wassermann and the Frei reaction were positive. The clinical diagnosis was pellagra and rectal stricture due to lymphopathia venereum. Despite an appropriate diet to combat the pellagra, the patient's diarrhea remained intractable, dementia developed, and she died two months after admission. Necropsy was performed six days later.

Necropsy revealed a chronic ulcerative granulomatous proctitis, with annular stricture, a severe secondary proctitis, periproctitis, anal tags and fistulae in ano. The symmetrical dermatitis of the hands and feet was typical of pellagra. The other significant findings included extreme fatty change of the liver, chronic infectious splenic swelling, and chronic salpingitis with adhesions. The cause of death was considered to be pellagra, with rectal stricture due to lymphopathia venereum as the contributory factor.

The relevant portions of the protocol follow: The ascending colon shows marked atrophy, and the sigmoid, polypoid thickening with small areas of ulceration. The wall of the rectum is markedly thickened and indurated, and the lowermost segment extending approximately 5 cm. above the anus shows marked stenosis. The mucous membrane at this site presents marked atrophy with numerous ulcers and incomplete fistulae extending into the indurated perirectal fat and connective tissue. The gross specimen is illustrated in Fig. 5.

Histologic examination of the rectum shows a chronic nonspecific proctitis with superimposed acute inflammation. Postmortem change is too advanced, however, to permit detailed study. Sections of the enlarged perirectal, lumbosacral and inguinal lymph nodes indicate a chronic lymphadenitis characterized by numerous plasma cell

Fig. 4.—Necropsy specimen (Case 4). Chronic ulcerative granulomatous proctitis with marked stenosis. Note rectovaginal fistula.

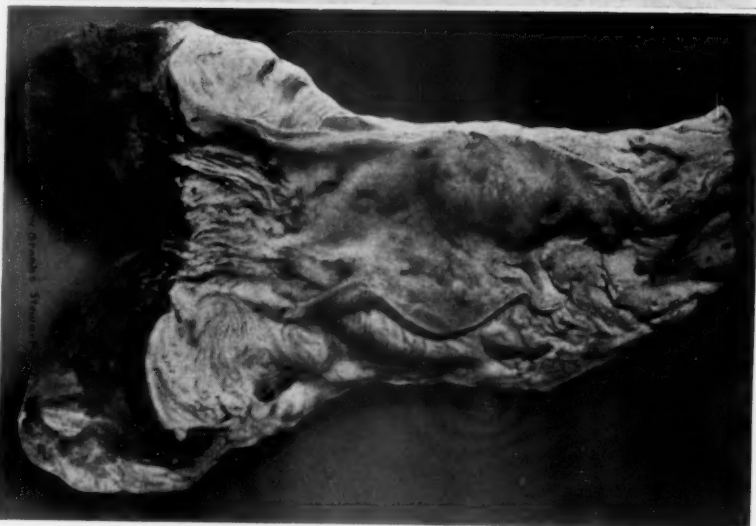Fig. 5.—Necropsy specimen (Case 5). Chronic ulcerative stenosing proctitis in Frei-positive case of rectal stricture associated with pellagra.

Fig. 6.—Necropsy specimen (Case 6). Chronic ulcerative stenosing proctitis and sigmoiditis in Frei-positive case of rectal stricture, associated with pellagra.

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nests. The skin shows conspicuous atrophy of the epidermis, as seen in the late stage of pellagra. The remaining organs show no significant change.

Case 6.—K. S., a Negro female, 36 years of age, had had a rectal stricture dilated during a previous admission to the hospital. The present admission was for treatment of pellagra, manifested by a sore, red tongue and a typical symmetrical dermatitis of the hands and feet. Rectal examination revealed a stricture of mild degree situated 4 cm. above the anus. The Frei reaction was positive, the Wassermann reaction negative. In addition to her stricture the patient presented a very large granulomatous lesion extending from the mons veneris to the anus; its appearance suggested granuloma venereum, and it improved following the intravenous administration of tartar emetic. The clinical diagnosis was pellagra, rectal stricture due to lymphopathia venereum, and granuloma venereum of the pudenda. The patient had a brief remission and then despite an appropriate antipellagra diet and continued dilatation of the rectal stricture, she became progressively weaker and more emaciated, gluteal bed sores appeared and dementia developed. Approximately ten months after the first admission she died as a result of pellagra, with rectal stricture as the contributory factor.

Anatomic Diagnosis—Lymphopathia venereum with rectal stricture, pellagra, and granuloma venereum of the vulva. The significant findings follow: The rectum shows marked thickening of the wall with resulting stenosis of the lumen commencing at a point 4 cm. above the anus and extending for a distance of approximately 10 cm. This lesion is sharply demarcated from the proximal uninvolved mucosa of the sigmoid. The mucous membrane of the stenosed area is scarred and extensively ulcerated. The perirectal tissue shows extensive fibrosis with numerous adhesions between the rectum, uterus and adnexa. The fallopian tubes are thickened. The vulva is indurated, hypertrophic and shows the extensive depigmentation seen in treated cases of granuloma venereum. The iliac and retroperitoneal lymph nodes are enlarged. The gross specimen is illustrated in Fig. 6.

Histologic examination of the rectum reveals postmortem change too far advanced to permit detailed examination. The enlarged inguinal, lumbosacral and periaortic lymph nodes show chronic nonspecific lymphadenitis. Sections of the involved portions of the skin present the late atrophic stage of pellagra.

This was the third Frei-positive case followed to necropsy and emphasizes, as does Case 5, the frequent association of rectal stricture and pellagra.
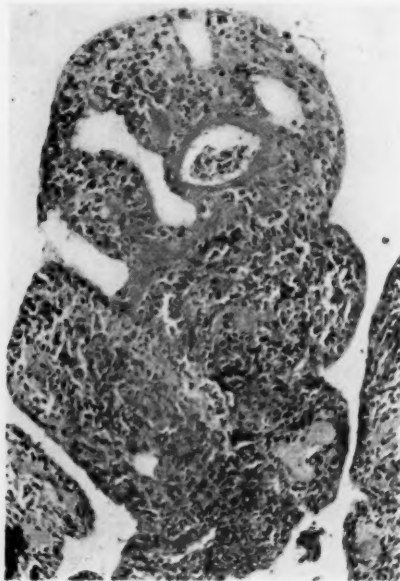
Fig. 7.—Polypoid mucosa of rectum showing dilated lymphatics with perilymphangitis.

COMMENT.—From the foregoing discussion it is evident that one may now separate from the chronic granulomata of the rectum and sigmoid another clinical and pathologic entity, *i.e.*, chronic ulcerative stenosing proctitis and periproctitis, the etiology of which is not syphilis, as has hitherto been incorrectly assumed, but lymphopathia venereum. This condition, recognized as early as 1897 by Kaufmann,[8] is described with uncertainty as to the

etiology, but otherwise in terms that might well be applied to the type of rectal stricture with which this paper is concerned. It cannot be denied categorically that an occasional rectal stricture may be luetic in origin, but the diagnosis of luetic stricture should be reserved for those rare cases in which an actual gumma is demonstrated in the mucosa or submucosa of the rectum.

Pathologic material obtained by biopsy, surgical resection and necropsy shows no specific inflammation indicative of syphilis, but rather a type of chronic inflammation resulting from lymphatic involvement, apparently common to all lesions of lymphopathia venereum. These manifestations occur in the pudenda as well as in the rectum, and they have also been observed in the scrotum and penis in cases of elephantiasis following total excision of infected inguinal nodes, as noted by Barthels and Biberstein.[7] These investigators have also described the lesions occurring in rectal stricture, as observed in two surgically resected specimens and three additional biopsies from patients with inflammatory rectal stricture and positive Frei reactions. The histologic findings may be briefly summarized as follows: destruction and ulceration of the mucosa, with a tendency upon regeneration to squamous metaplasia; infiltration and disruption of the muscularis by focal miliary accumulations of leukocytes and plasma cells, with subsequent fibrosis; dilatation of the lymphatics, with perilymphangitis and endolymphangitis; marked endarteritis and narrowing of the blood vessels, as in any chronic inflammatory lesion. The indurated perirectal fat and connective tissue likewise show perilymphangitic and perivascular infiltration. These observations were confirmed by Wien, Perlstein and Neiman,[9] who reported two Frei-positive cases of rectal stricture followed to necropsy. The features enumerated above appear to be constant and we have repeatedly observed them in our biopsy and necropsy material (Fig. 7). It may be emphasized at this point, that rectal or anal biopsy should always be supplemented by the Frei test, since biopsy alone scarcely enables one to make a diagnosis more definite than chronic inflammation suggestive of lymphopathia venereum.

The pathologic process is progressive and is not necessarily confined to the rectum; in severe cases, as Kaufmann[8] was well aware, it may extend to the sigmoid. When this occurs, there is a tendency to fistulae between the sigmoid and adherent loops of small intestine, as observed in two of our necropsies. In Case 2, the sigmoid as well as the rectum was involved and an ileosigmoidal fistula had developed. In Case 3, an ileosigmoidal fistula was also encountered, apparently as a result of walling off of a sigmoid perforation, too late, however, to avoid peritonitis.

This series of necropsies serves to illustrate some of the complications to which patients with inflammatory rectal stricture are subject. In Cases 1 and 2, death was due to terminal cardiac failure, brought on in one instance by an acute ulcerative colitis and in the other by severely infected bedsores. In Cases 3 and 4, death was caused by peritonitis, in the latter instance as a result of a perforated decubitus ulcer of the sigmoid due to impacted fecal

masses above a tight rectal stricture. In Cases 5 and 6, the cause of death was pellagra, associated with severe secondary proctitis, which failed to respond to the usual therapy.

SUMMARY

(1) A clinical and pathologic study of six cases of rectal stricture due to lymphopathia venereum observed at necropsy within the period of one year is presented.

(2) Four cases were observed clinically and are among the few recorded instances of rectal stricture due to lymphopathia venereum which came to necropsy diagnosed as such. Positive Frei reactions were obtained in three of these cases.

(3) The findings clearly indicate that the advanced stage of involvement of the rectum by the virus of lymphopathia venereum is represented by the pathologic entity of chronic ulcerative stenosing proctitis and sigmoiditis, the etiology of which has hitherto been obscure.

(4) The most frequent manifestation of lymphopathia venereum in the female is rectal stricture.

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SUPPURATIVE ARTHRITIS OF THE SACRO-ILIAC JOINT

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Suppuration of the sacro-iliac joint is a clinical entity which occurs more frequently than is commonly believed. If this condition is kept in mind by the physician when an acute lesion of obscure etiology is encountered in the lumbar or gluteal regions with unilateral lower abdominal symptoms, the diagnosis would be made at a more favorable phase of the disease, with consequent earlier appropriate drainage and a better prognosis, as the mortality rate in this lesion is relatively high even if recognized early.

This disease is only occasionally mentioned in text-books on surgery, and then by name only; no adequate description of the condition was found. Jones and Lovett do not mention the sacro-iliac joint in discussing pyogenic infections of joints, nor does Campbell in his description of acute affections of joints. The fact that the prognosis is bad is mentioned,[2, 6, 7] but no statistics are given. Such opinions regarding prognosis are probably based upon studies of tuberculosis of the sacro-iliac joint,[9] a subject which has been thoroughly studied, and about which the literature is quite voluminous. Only a few articles in English on suppurative arthritis of the sacro-iliac joints could be found under that title. Poore[11] wrote an excellent article on this subject in 1878, and reported two cases of his own and collected 56 cases from the literature, mainly French. A number of articles were found under the title of "Psoitis."[4, 6, 14, 15] The clinical picture described in these corresponded almost exactly with that found in our cases, leading us to believe that they were true suppurations of the sacro-iliac joint, but that only the secondary psoas abscesses were recognized. Young[16] reported what was probably a true primary pyogenic infection of the sacro-iliac joint. The patient was treated by incision but the technic of the operation was not described.

During the past three years five cases have been diagnosed and treated by the author. Six other cases have been seen either in consultation or by courtesy of other surgeons. The first five cases are reported in some detail. Of that number, two have died, two are well, and one healed but is now again in the hospital with an acute exacerbation of osteomyelitis of the pelvis. After studying this group carefully we now feel that certain errors can be avoided, enabling one to make the diagnosis more readily and treat the lesion more efficiently.

Pathologic Anatomy.—Clarke[4] gives an excellent description of the pathology in this lesion. His postmortem findings were somewhat similar to those found in Case 3 of our series, upon whom an autopsy was performed.

The disease may start within the joint itself, in the ilium, or sacrum adjacent to the joint. It would seem to be secondary to a blood stream infec-

tion, in as much as the clinical course is similar to pyogenic arthritis in other
joints. In one instance in the series (Case 3), the primary focus was proba-
bly in the ilium, between the posterior superior and inferior spines, so that
this case may possibly be considered as an acute arthritis complicating
osteomyelitis of the ilium. In the other four instances no definite site could
be precisely determined, but the symptoms were well localized over the sacro-
iliac joint and in the iliac fossa of the abdomen in all five cases. At operation
no free pus was found until the pelvic cavity was entered, in Cases 1, 2 and 4.
In Case 3 no free pus was found although culture was positive from a sus-
picious looking area in the ilium, before entering the joint. It is difficult to
state whether this represented the original focus of infection, or whether the
disease had extended to this spot from the joint. Case 5 was not operated
upon and autopsy was refused. All these patients had abdominal symptoms
early in the disease. All roentgenologic evidence pointed to pathology in the
sacro-iliac joint, even in Case 3. There was no evidence of osteomyelitis of
the ilium or sacrum except at the joint surfaces before operation. Of course,
they developed osteomyelitis of the ilium, sacrum, ischium, or all of them,
later. For these reasons, we believe that these patients had a primary infec-
tion of the sacro-iliac joint rather than a secondary pyogenic arthritis fol-
lowing osteomyelitis of the ilium or other pelvic bones. Thus, they may be
considered as primary acute pyogenic arthritides.

As soon as the sacro-iliac joint is involved, the pus under pressure, fol-
lowing the path of least resistance, quickly breaks through the anterior sacro-
iliac ligament, which is very thin and easily ruptured.[13] Sashin says that "the
anterior sacro-iliac ligament is a thin, rather weak structure," and, "upon
slight pubic separation it is stretched and very often tears."

What paths may the pus follow? Passing through this aperture, the pus
from the joint burrows under the iliacus muscle and fills the iliac fossa.
When this fossa is filled, the pus may take one of several courses:

(1) It may follow the tendon of the iliopsoas muscle, in which event it
will become superficial on the inner aspect of the thigh.

(2) If at Poupart's ligament, instead of following the iliopsoas, it fol-
lows the pectineus muscle in cases with necrosis of intervening tissues, it will
become superficial on the posterior aspect of the thigh.

(3) It may enter the hip joint through a bursa which is found between
the iliopsoas tendon and the anterior part of the capsule of the joint, if the
bursa communicates with the joint, as it sometimes does. One in this series
took this pathway (Case 3).

(4) Should it follow the tendon of the obturator internus, which passes
out of the pelvis through the lesser sacrosciatic foramen, the abscess will point
behind the hip joint.

(5) If the pathway be along the course of the pyriformis muscle, which
passes through the greater sacrosciatic foramen, a low gluteal abscess occurs.

(6) Should its course be upward from the iliac fossa into the lumbar
region, a lumbar abscess forms.

(7) The pus may travel anteriorly and upward towards the crest of the ilium and break through anteriorly onto the abdominal wall.

When muscle planes have broken down, the pus follows very unorthodox pathways. The author has observed a penetration of the pelvic floor and discharge through the vagina in a tuberculous lesion of the sacro-iliac joint, and in one case of this series the rectal wall was eroded, and a rectal fistula produced. Goldman[5] reports a case of blind internal fistula with arthritis of the sacro-iliac joint. It is hard to determine from the report which was the primary lesion.

The osteomyelitic process in the ilium may be sufficiently widespread to break through the dome of the acetabulum and produce a secondary suppurative arthritis of the hip joint. This occurred in one instance, while in another the ilium was broken through, and the pus followed the fascial planes of the gluteal muscles and traveled down to the outer side of the thigh.

Symptoms and Physical Signs.—The onset is similar to an acute osteomyelitis in any of the long bones. The temperature may vary from 100° to 104° F., and be preceded by chills. The systemic symptoms vary with the virulence of the infection. Pain cannot be localized very definitely. Patients are apt to point to the buttocks and hip of the affected side, but nearly all complain of pain in either the lower right or left abdominal quadrant, depending on whether the right or left sacro-iliac joint is affected. One patient had persistent vomiting for several days, which was very suggestive of intestinal obstruction. It is the abdominal symptoms that are misleading, and often confusing, in making an early diagnosis. These patients appear very acutely ill. Upon examination some flexion of the hip on the affected side is noted. Flexion of the hip with the knees extended causes severe pain, and is markedly restricted, due to the action of the biceps and semitendinosus muscles which produce motion in the sacro-iliac joint through their pull on the ischium. Extension is restricted, due to the spasm of the iliopsoas muscle. Rotation of the body is extremely painful. This is due to the hinge-like motion on a transverse axis in the sacro-iliac joint, producing an opening and closing movement of the affected joint. Pressure elicits a definite, tender, painful spot directly over the surface projection of the sacro-iliac joint. If the pus has broken through anteriorly, which occurred in all the cases, a definite mass is palpable in the iliac fossa over the lower lateral aspect of the abdomen, as well as by rectal or vaginal examination. There is a fulness in the upper thigh, inguinal region, lateral and posterior aspects of the hip joint, and gross swelling and edema of the entire thigh has been observed. In some instances the swelling has been due entirely to edema, and in others to extravasation of pus in the fascial planes. Edematous swelling always precedes suppuration. It would seem that the edema is due to pressure on the iliac vessels after pus has accumulated in the iliac fossa. Due to the early involvement of the iliopectineal bursa, confusion of this lesion with disease of the hip joint arises. One patient developed a foot drop which persisted until death. This could not be explained except by pressure on the lumbosacral plexus. Later on in

the course of the disease, due either to improper drainage or to the virulence of the infection, the hip joint may become involved, and then the physical signs of suppurative arthritis of the hip joint are present; that is, restriction of all motions, and increased flexion deformity. Depending upon which sacro-iliac is involved, pressure over the lower lateral abdominal quadrants will produce pain on the side of the sacro-iliac joint that is affected.

Diagnosis.—The diagnosis is by no means easy to make, but the keeping in mind of the possibility of this lesion is the first criterion for its more frequent recognition. The initial symptom is pain, gradually increasing in severity, and definitely localized over the sacro-iliac joint. Torsion movements of the trunk provoke excruciating pain, so that considerable reliance should be placed on the difficulty experienced by the patient in turning from side to side even while lying in bed. This is so, particularly before the pus ruptures into the pelvis. This clinical picture, plus such objective signs as a mass in the iliac fossa, palpable either through the abdomen, vagina, or rectum; swelling of the upper thigh, especially under the iliopsoas tendon; fever ranging from 102° to 104° F.; a rapid pulse; a high leukocytosis with a high polymorphonuclear count; and a negative roentgenogram, should render the diagnosis possible. If the patient is not seen until the second or third week, roentgenologic examination will be of definite help, for by that time some destruction is usually demonstrable in either the iliac or sacral portions of the articulation.

Tuberculosis of the lumbar spine complicated by a psoas abscess is easily differentiated. It seems sufficient to mention such differences as the positive roentgenographic evidence of the vertebral lesion, the gradual onset, and the history of the protracted illness in tuberculosis.

It must be also differentiated from appendicitis, as the general symptoms may be the same in both lesions. However, the physical signs are different. In appendicitis, pain is usually localized in the right lower quadrant, but there is no swelling of the upper thigh, and rotation of the trunk does not produce excruciating pain, nor is there pain on pressure over the sacro-iliac joint.

Osteomyelitis of the neck of the femur may simulate sacro-iliac osteomyelitis at the onset, but in the former the physical signs are limited to the hip; they are: restriction of motion in all directions, spasm of all hip muscles, no tenderness over the sacro-iliac joint, and no mass in the iliac fossa. There is a greater degree of hip flexion deformity in osteomyelitis of the femoral neck than in sacro-iliac disease, and rotation of the trunk does not produce pain if the affected hip is steadied firmly during the maneuver. The first case in this series was mistaken for a hip joint lesion.

Prognosis.—The prognosis at best is very poor. It depends essentially on the virulence of the organism; the resistance of the patient; and the adequacy of the drainage. An early diagnosis with proper drainage affords the best outlook. The age of the patient is a factor; the older they are, the less favorable the outcome. If diagnosed and drained very early, the mortality rate

should not be greater than that of pyogenic arthritis of any other joint in the body, but the difficulty lies in the remoteness of the focus from the obvious objective abdominal signs and symptoms. The usual treatment so far has been the drainage of the secondary abscesses, rather than the primary joint lesion. This affects the prognosis unfavorably by increasing the morbidity. Another factor is the ease with which complications may be overlooked, due to the difficulties of making a thorough examination during the early part of the illness. Pain is so acute that movement is almost impossible. In this series, a hip infection was unrecognized in one instance, and in another, a lumbar abscess was undiagnosed, largely because of fixed decubitis and resistance to movement. The lumbar abscess was found at autopsy, accompanied by necrosis of practically all soft tissues up to the first lumbar vertebra on the affected side. If this had been discovered in time, and proper drainage provided, the patient might have survived, although this is questionable as there was a very virulent blood stream infection.

Complications.—The principal complications are the result of abscesses forming in the various locations previously mentioned. In the severe infections the muscles in the path of the pus are completely destroyed, as shown in the postmortem examination of Case 3. The hip joint may be involved, either by extension forward of the osteomyelitic process within the ilium, or through the iliopectineal bursa. Osteomyelitis of the adjacent bones always follows.

Treatment.—As has been mentioned before, drainage of secondary abscesses has been the routine surgical procedure up to the present time, although as long ago as 1889 Gongolpre[6] described a method of draining the iliac cavity by trephining the pelvis. In 1899 Bardenheuer[1] described the essentially proper approach for radical operations in tuberculous infections of the sacro-iliac joint; Picque[10] in 1909 and Chandler[3] in 1933 have done likewise.

The approach used in each instance in this series was similar to that described by Chandler,[3] who drained the sacro-iliac joint for pneumococcic infection, although we were not familiar with his method until after operating on the first case. The basic principle in any approach is to provide dependent drainage from behind through the ilium.

The operation consists of an exposure of the posteromedian aspect of the ilium through a skin incision along the posterior half of the iliac crest downward to the posterior inferior spine. The gluteus maximus and medius muscles are then resected subperiosteally, sufficiently lateral to expose that part of the ilium which lies directly over the sacro-iliac joint. The joint is exposed through a large window by the resection of a block of bone from the posterior aspect of the ilium lying over the sacro-iliac joint. That part of the sacrum which goes to form the joint with the ilium is removed. This permits the admission of at least one or two fingers into the pelvis. The iliacus muscle is felt, and lifted from behind. Free pus is usually not found until the pelvic cavity is entered. The wound is packed with vaseline gauze

and left wide open. A plaster of paris spica is applied if the patient's condition permits. If not, a Buck's extension is used until such time as a plaster spica can be applied. The wounds are dressed as infrequently as possible, preferably not for two or three weeks, unless a rise in temperature indicates inadequate drainage, or signs of hemorrhage appear. We have never had to remove the packing because of hemorrhage, not having encountered this complication as yet. If secondary abscesses develop in the thigh or lumbar region which cannot drain through the original incision, these are incised. In
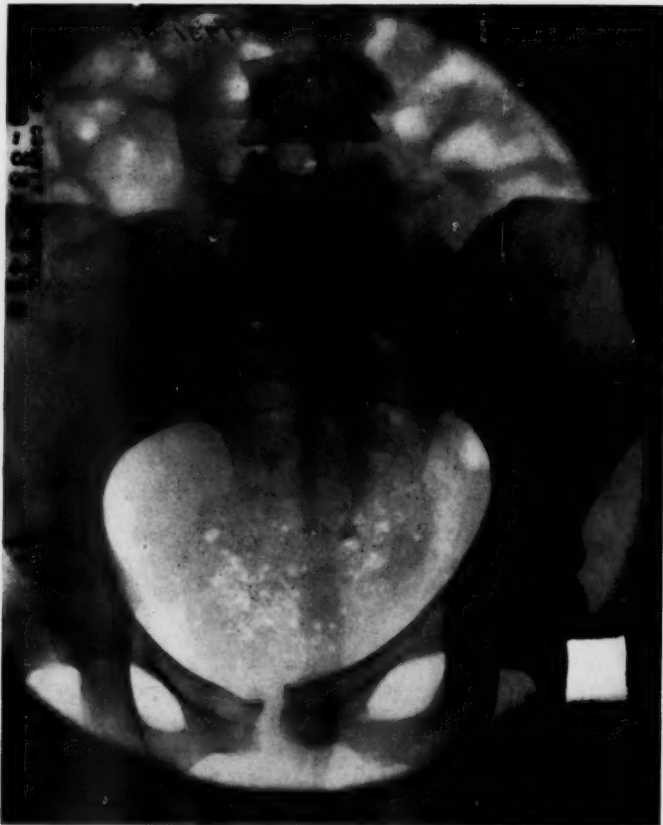
FIG. 1.—(Case 1.) Preoperative roentgenogram showing definite destruction in the lower part of the left sacro-iliac joint.

other words, our postoperative treatment follows the usual principles as advocated by Orr in the treatment of osteomyelitis of the long bones.

These patients are often very ill from dehydration and sepsis, and unable to stand the radical operation at the moment. In such instances it is wise to drain the secondary abscesses in the soft parts, thereby diminishing the amount of toxic absorption, and build up the general condition of the patient by the free use of fluids, intravenously or otherwise, supplemented by blood transfusions. As soon as the general condition has been improved, the radical operation for draining the original focus of infection should be performed.

FIG. 2.—(Case 1.)   Postoperative roentgenogram showing operative window
through ilium and sacrum at sacro-iliac joint.
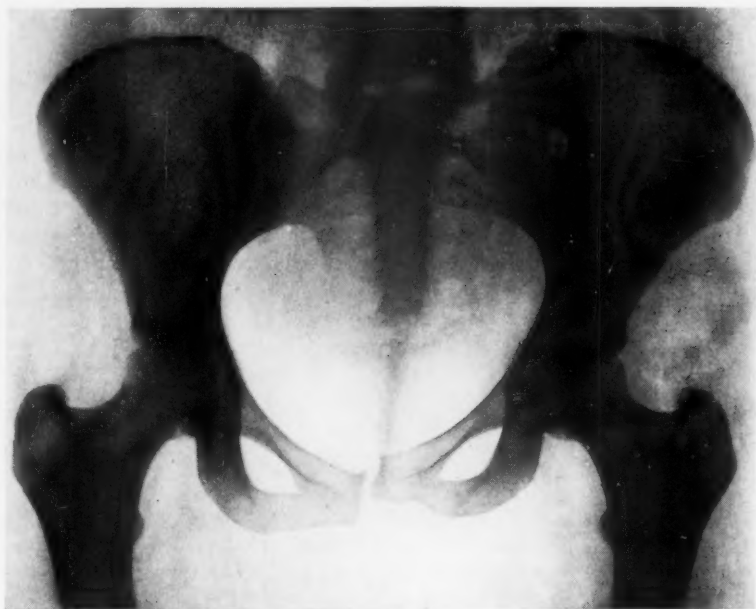
FIG. 3.—(Case 1.)   Roentgenogram taken 13 months after operation, showing a filling
in of the operative defect with apparently a small sequestrum present, which is not caus-
ing any trouble.

CASE REPORTS

Case 1.—Mrs. D., aged 24, white, female. Admitted March 9, 1933, to the Gynecologic Service complaining of pain in the lower back. Patient stated that the pain in the back started spontaneously about one week before admission, and that she first noticed it on attempting to turn. It gradually became worse until admission to the hospital. She also gave a history of having fallen on her abdomen five weeks previously, at which time she was two months pregnant. This was followed by a slight bloody discharge, and abortion two weeks later. She had no chills or fever at that time and had no medical attention.

Relevant physical examination on admission was as follows: Temperature on admission was 101° F.; respirations 22. She was pale, well-nourished, well-developed, poor hemic component, first heart sound roughened and had a systolic blow. Abdomen was soft. There was tenderness over the symphysis pubis, and a yellowish discharge from the vagina. There was tenderness over the left sacro-iliac joint. Hips were negative. Blood count on admission showed 9,800 white blood cells; 69 per cent polymorphonuclears; 2,624,000 red blood cells and hemoglobin of 55 per cent. A diagnosis of incomplete abortion and sacro-iliac arthritis was made.

An obstetric consultation on March 11, 1933, showed a soft cervix, large uterus, no masses or tenderness in either fornix. A diagnosis of pregnancy was made. Another gynecologic examination on March 14, 1933, showed the cervix closed, uterus apparently normal and markedly antiflexed. No pelvic masses or tenderness found. This consultation was requested because of the continued high temperature and increasing pain in the back in order to rule out sepsis in pelvic organs.

Roentgenogram March 15, 1933, showed a definite area of destruction in the lower portion of the left sacro-iliac joint.

On March 16, 1933, the patient was transferred to the Orthopedic Service where traction was applied to the leg which gave marked relief of symptoms, although the temperature persisted. On March 28, 1933, she exhibited a marked diffuse swelling over the left hip and thigh in spite of the fact that motions of the hip were free. There was marked tenderness over the left sacro-iliac joint. A provisional diagnosis of sacro-iliac suppuration was made.

Roentgenogram March 29, 1933, showed increased destruction. On the same day the operation as previously described was performed and followed immediately by a blood transfusion. An interesting point observed as the sacro-iliac joint was entered, was the free mobility of the iliac portion of the joint. It was actually a pathologic dislocation of the ilium upward on the sacrum. Free pus was not encountered until the pelvic cavity was entered through the sacrum, the pus having entered the iliac fossa by breaking through the anterior ligament of the joint. The temperature range was between 99° and 105° F. up to April 11, 1933. From then on it gradually declined to normal. Patient was allowed up on wheel chair on June 23, 1933, and she was discharged on July 10, 1933, walking well, wound healed, and wearing a sacro-iliac belt.

Case 2.—Mr. F., aged 20 years, male, white. Admitted to the hospital on March 31, 1933, complaining of pain in the back and general weakness. He stated that three weeks before admission, while working on a truck, he became weak. Had to stop work, went to bed, then felt better and was able to get about until the day before admission, when he complained of severe pain on even slight movement of the legs.

The relevant physical findings on admission: Temperature 104.2° F., pulse 110, respirations 22. A fairly well nourished white male, complaining of pain in the back, and moving with great difficulty. He had severe pain on pressure over the left sacro-iliac joint. There were spasm of the lumbar muscles, and pain on flexion and extension of the thighs. A tentative diagnosis of sacro-iliac infection and sciatica was made at this time.

An attempt was made to apply traction to the left leg to avoid flexion contractures
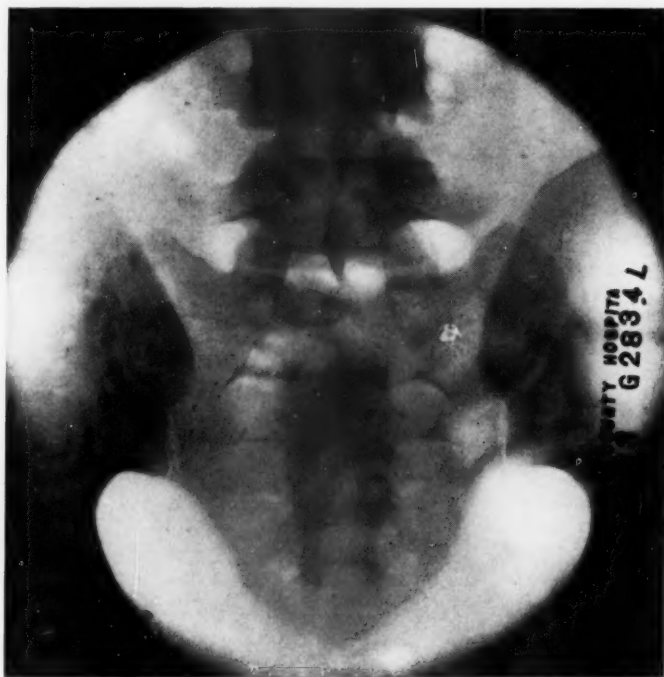
FIG. 4.—(Case 2.) Roentgenogram showing area of destruction about the lower half of the left sacro-iliac joint.
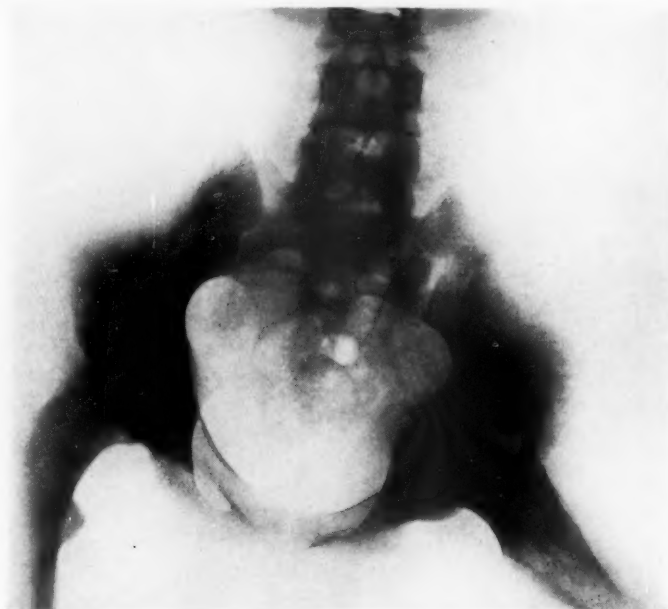

FIG. 5.—(Case 2.) Roentgenogram showing increased density of the ilium and bone proliferation inside of the pelvis over the dome of the acetabulum, and destruction of the hip joint, indicating that the disease extended downward along the ilium and involved the hip joint, producing a secondary suppurative arthritis of the hip joint.

at the hip and knee. This could not be tolerated even though as little as three pounds of weight was applied. It was removed and severe contractures did develop.

During the course of the disease, it was impossible to tell exactly when he developed an infection of the hip joint which drained through the back, as this joint was never directly drained. It healed with bony ankylosis and severe flexion deformity.

Operation was performed April 13, 1933, at which time 8 cc. of pus was evacuated from the soft tissues over the sacrum. Five transfusions were given: April, 19, May 3, 5, 24, and June 9, 1933.

A second operation for radical drainage was performed on May 4, 1933. The left sacro-iliac joint was exposed; on removing the block of bone from the ilium the articular cartilage of the sacrum was found to be eroded. The underlying bone, which appeared gray and necrotic, was easily removed by a curette, but no free pus was encountered. In this instance insufficient bone was removed from the sacrum. The pelvic cavity was not entered. Wound packed with vaseline gauze.

In August 1933, temperature 104°-105° F., a sinus opened spontaneously over the left lower abdomen. Under anesthesia this was enlarged and found to communicate with the operative wound through the iliac fossa; through and through drains were inserted.

The patient's general condition up to this time had been poor, but after the spontaneous evacuation of the pus in the iliac fossa through the abdominal sinus the temperature began to subside rapidly, and reached normal about October 1. Five months later, March 17, 1934, he was discharged from the hospital walking with a marked limp, the result of a knee and hip flexion contracture. The knee contracture was completely corrected by wedge casts. On April 18, 1934, he was readmitted for the correction of the hip flexion deformity by a subtrochanteric osteotomy of the left femur, and a subperiosteal separation of the hip flexors from the anterior iliac spine. This was successful, and he was discharged July 28, 1934.

In retrospect it is evident that adequate drainage of the iliac fossa was never established until spontaneous evacuation through the abdominal sinus, five months after the inception of the disease. Had proper drainage been provided, ankylosis of the hip would probably have been prevented, and his convalescence materially shortened.

Laboratory Findings.—Blood cultures were negative. Smear of the pus showed gram positive cocci in short chains, and culture, streptococcus brevis. Microscopic examination of bone removed from the sacro-iliac joint showed marked infiltration of bone marrow spaces by monocytic cells, and occasional areas of necrosis of bone spicules.

Roentgenologic Findings.—Five days after admission, April 5, 1933, there was a shadow in the lower part of the left sacro-iliac joint, suspicious of osteitis. Thirteen days later, and five days after the first incision and drainage, an increased area of destruction was reported. On April 27, 1933, nine days later, and one week before radical drainage, a third roentgenogram demonstrated still greater destruction of the joint.

Six months after operation, January 26, 1934, there was no evidence of active bone pathology in the sacro-iliac joint. The lesion had healed. There was a definite subperiosteal deposit of bone along the inner surface of the ilium within the pelvis, from the sacro-iliac joint to the ischial spine just anterior to the acetabulum, indicative of invasion of the hip joint via this route.

Case 3.—Miss A. Q., aged 19, white female. Admitted to the hospital January 26, 1934, complaining of pain in the right thigh. About four weeks before admission she had had a "cold." About five days after this, before the "cold" had cleared up, she noticed that on moving the right leg she had a dull pain in the thigh. For two weeks, despite progressively increasing pain, she continued to work, when she slipped and fell with both lower extremities abducted. She was carried home, and the pain became severe, and the leg stiff. Although no other joints were affected, the condition was diagnosed as rheumatic fever, and the patient treated at home for a week.

On admission the temperature was 102° F., pulse 112, and respirations 24. The patient was a well-developed girl, appearing acutely ill, moderately anemic, and evidently in pain. There was a systolic blow at the apex, which was not transmitted to the axilla. The abdomen was tense, although there was no definite rigidity. Some tenderness of both right and left lower abdominal quadrants was elicited. No masses were palpable. There were swelling and tenderness of the upper half of the right thigh, without local redness of the skin. No areas of fluctuation were present. The leg was held in 75° of flexion; all movements of the knee were limited, and any motion of the hip joint greatly aggravated the pain. Tenderness on pressure over the right shoulder joint was noted, and dull pain occurred on movement. A provisional diagnosis of acute infectious arthritis of the right hip, with a mild secondary anemia and mitral disease was made.

Traction was applied, ameliorating the pain. The swelling in the upper thigh persisted. An attempt was made to aspirate the joint, but no fluid was obtained. Four
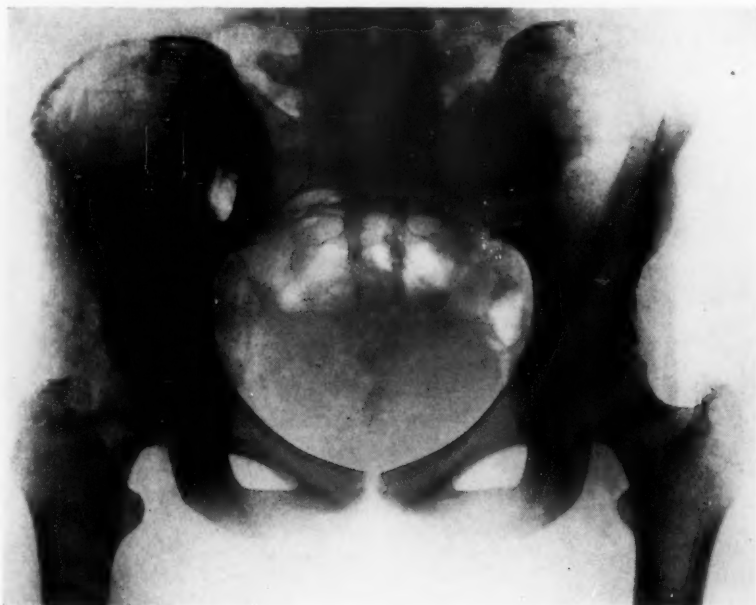
FIG. 6.—(Case 3.) Roentgenogram showing operative window through the sacro-iliac joint, and early destruction of the hip joint. This hip joint became infected through the iliopectineal bursa.

days after admission the temperature had risen to 104.2° F., the right shoulder pain persisted, pain in the hip was localized over the great trochanter. A medical consultation resulted in an opinion that the condition was not rheumatic fever. A gynecologic survey suggested the possibility of salpingitis.

Two days later, February 2, 1934, rectal examination revealed definite tenderness over the right sacro-iliac joint, but no evidence of a mass in the iliac fossa. On February 6, swelling of the upper thigh had increased, the right sacro-iliac was very tender to palpation, and roentgenograms showed a suspicious area of osteitis in the lower angle of the joint. Arthrotomy was performed two days later. Within the cancellous portion of the ilium, about one-half inch beneath the outer table, a few drops of pus were encountered; culture showed a staphylococcus aureus. Penetration was continued through the ilium into the sacro-iliac joint, and thence through the sacrum into the pelvis. The wound was packed with vaseline gauze.

The immediate postoperative reaction was stormy. The fever subsided somewhat, but continued to spike to 102° or 103° F. On February 23, 15 days postoperative, the patient began to vomit. No signs of intestinal obstruction were elicited. The attack subsided. On March 15 pain in the right leg, which had been dull and intermittent, increased in severity and constancy. On aspiration of the hip joint a turbid, light yellow fluid was obtained, which on culture showed staphylococcus aureus. Roentgenograms disclosed some diminution of the joint space and roughening of the articular surfaces. Drainage of the hip through an anterior incision was instituted.

In May 1934 a massive soft tissue abscess, which had gradually formed on the lateral surface of the thigh, was drained. The patient was extremely septic, pulse rapid, and the temperature, which had been ranging from 102° to 103° F., began to subside. Her general condition rapidly became weaker, and death occurred on May 26, 1934.

Throughout the illness repeated transfusions were given. Glucose and salt solutions were administered by infusion and clysis. Iron and liver therapy was used in conjunction with the transfusions to combat the severe secondary anemia.

Laboratory Findings.—Two blood cultures were taken but were contaminated. Blood Wassermann was negative. Gonococcic fixation test was negative. Specimens of the removed bone, on section, showed acute osteomyelitis.

Postmortem Examination.—On stripping the psoas muscle a large abscess extending from the brim of the pelvis upward to the level of the first lumbar vertebra on the right side of the abdomen was found. The muscles and fatty tissue had all undergone necrosis. The anterior surface of the sacrum was roughened and studded with necrotic areas. The head of the right femur was similarly involved. Diagnosis: Chronic osteomyelitis of the sacrum, right ilium and right femur.

COMMENT.—The right lumbar abscess was never diagnosed. It is doubtful whether drainage of this abscess would have altered the course of the disease, in as much as the essential picture was that of overwhelming infection.

Case 4.—Mr. S., aged 5 years, white, male. Admitted to the General Surgical Service March 16, 1932, complaining of pain in the abdomen of two days' duration, and pain in the right hip for one week. Temperature 101.8° F., pulse 128, respirations 28. Twelve days prior he had been knocked down by a bicycle. The following day a swelling in the right gluteal region was noted, and some pain complained of, which disappeared after using a liniment. Six days later a limp developed, pain in the right buttock returned, and abdominal pain began on the tenth day.

On admission the patient was toxic, moderately dehydrated, mucous membranes dry, tongue coated and both legs were flexed on the abdomen. Attempts to extend the thighs provoked pain, but hip motions within a restricted range were free and painless. There was generalized abdominal tenderness, with maximum intensity in the right lower quadrant, and rebound tenderness referred to McBurney's point. Three days after admission a swelling and induration on the medical aspect of the right thigh appeared. Operation was performed to institute drainage, but no pus was obtained. Six days later, on aspiration in the gluteal region, thick pus was obtained. Culture showed a growth of staphylococcus aureus.

On the following day, March 24, the area was incised, and the hip joint exposed. No infection observed. A pus pocket was found and evacuated posteriorly in the region of the right sacro-iliac joint. Penrose drains were inserted. There was some remission of the temperature for a week, but then a rapid rise occurred, spiking from 104° to 107° F. Blood culture at that time was negative. The fever persisted for many weeks, subsiding by lysis during July. He was discharged in October 1932, seven months after admission.

Eighteen months later, March 29, 1934, the patient was readmitted complaining of right lower quadrant pain of two days' duration, associated with vomiting. Both hips

were flexed on the abdomen. There were muscular rigidity and right lower quadrant tenderness. A diagnosis of acute appendicitis was made. On consultation with the General Surgical department the author disagreed with the diagnosis, and advised drainage of the sacro-iliac for osteomyelitis of the iliac bone. This was done by an associate, who did not carry the penetration through the entire pelvic wall. The abdomen was opened at the same time. Findings.—No free fluid, appendix normal, a retroperitoneal mass in the right iliac fossa. Two days after operation pus drained from the sacro-iliac wound. Convalescence was complicated by varicella, for which transfer to a contagious disease hospital was necessary. On return, May 9, 1934, septic temperature continued. The hip joint was opened on May 17. No infection was

FIG. 7.—(Case 4.) Roentgenogram showing complete fusion of the sacro-iliac joint and involvement of the entire ilium. This patient was never adequately drained. We saw him during an acute exacerbation after the primary lesion had been healed and the patient had been walking about.

found within the joint, but a pocket was located beneath the lesser trochanter on the femoral shaft, evidently an extension along the iliopsoas muscle from the iliac fossa. The temperature subsided in seven days, and he was discharged two months later, July 15, 1934.

COMMENT.—On the first admission the diagnosis was entirely missed, and definitely overlooked on his second admission, resulting in a laparotomy with negative findings. Roentgenograms demonstrated involvement of the entire ilium and part of the sacrum. The pelvis was never adequately drained until

the secondary abscess areas, especially that along the iliopsoas tendon, were evacuated.

Case 5.—Mrs. P., aged 46, colored, female. Admitted to the hospital November 19, 1934, because of pain in the region of the right hip. Onset was acute. Three weeks before admission she had chills and fever, followed by pain in the right hip region, which gradually became worse until it was so severe that she was confined to bed. Pain was aggravated by motion, and relieved by rest. It radiated down the thigh to the knee and ankle. No history of injury. Temperature on admission was 100° F., pulse 112, respirations 26.

Relevant physical examination showed a middle-aged emaciated Negress, apparently chronically ill; unable to sit or stand. Some crepitating râles at the base of the lungs. There was a definite fulness about the right hip joint with tenderness in the inguinal region just below Poupart's ligament. Flexion of the hip was fair; rotation somewhat painful. Tenderness was elicited on pressure over the right sacro-iliac joint. The hip was maintained in about 10° flexion. The patient appeared very ill.

An orthopedic survey was made November 27, 1934. At that time there were two masses in the lower right abdomen: the one toward the midline was rather firm and movable, and not tender; a typical fibroid tumor in the uterus. The other mass filled the entire right iliac fossa on the right side. The groin showed a distinct fulness below Poupart's ligament. Vaginal examination revealed a fulness in the right iliac fossa, and a downward displacement of the uterus. There was also a distinct mass behind the hip joint, in the lower gluteal region. Tenderness was present on pressure over the sacro-iliac joint. Roentgenograms were negative for bone pathology. No pus was obtained from aspirating the mass in the iliac fossa, but was obtained from the swelling behind the hip joint.

A diagnosis of sacro-iliac disease was made, but radical drainage was delayed on account of the poor general condition of the patient. The gluteal abscess was drained December 3, 1934. Death occurred ten days later, and no autopsy could be obtained.

Laboratory Findings.—Blood Wassermann was negative. Culture of pus from the hip joint showed a nonhemolytic streptococcus. Smear showed many gram positive cocci in short chains.

CONCLUSIONS

(1) Five cases with suppuration of the sacro-iliac joint are reported.

(2) The difficulty in making an early diagnosis has been pointed out.

(3) A plea is made for earlier diagnosis and proper adequate drainage in these cases.

(4) The group reported had a mortality of 40 per cent.

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SERUM PHOSPHATASE IN FRACTURE REPAIR

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A study of a series of major fractures has been conducted to determine the possible clinical significance and the relationship between the healing of fractures and the activity of the enzyme phosphatase of the serum. The importance of the enzyme phosphatase in phosphorus and bone metabolism has been clearly demonstrated in recent years. Early studies by Robison[1] showed that the enzyme was capable of hydrolyzing phosphoric esters such as glycerophosphates and hexosephosphates into inorganic phosphates. Robison and Soames[2] demonstrated that bone, and especially growing bone, contained a high concentration of the enzyme and concluded that a relationship existed between the enzyme and bone metabolism. Their hypothesis was as follows: "Osteoblasts and hypertrophic cartilage cells and certain cells of the inner border of the periosteum in a growing bone contain or can secrete a very active phosphatase which, by hydrolyzing the salts of phosphoric esters brought to the ossifying zone by the blood stream, cause a local increase in the concentration of phosphate ions. The solubility product for calcium phosphate, which is probably very nearly reached at the concentration of inorganic phosphate and ionized calcium normally present in the circulating plasma at normal plasma Ph, is thus exceeded locally and a deposition of the calcium phosphate is brought about in the neighborhood of the cells which secrete the active enzyme."

It is to be expected therefore that with the formation of callus in the process of fracture repair, a local increase in the phosphatase activity will be found. Regen and Wilkins,[3] Botterell and King,[4] in experimental work on animals have shown that the phosphatase activity of bone at the site of fracture was greatly increased as compared with that of bone from other sites in the same animal. They found that the increase may be as much as ten to twenty times normal and reached its maximum about three weeks following fracture. The phosphatase activity of the bone the day following fracture showed no change from the normal and no appreciable increase was noted until about the fourth day following fracture.

Increase in serum phosphatase activity has been reported in many pathologic bone conditions, notably Paget's disease, osteogenic sarcoma and osteitis fibrosa cystica. It has also been repeatedly demonstrated that the phosphatase activity of the involved bone in these conditions is extremely high. Franseen and McLean[5] have recently shown that in cases of osteogenic sarcoma the level of the serum phosphatase can be used as an index of the activity of the tumor. They found that with surgical removal of the tumor mass the plasma

phosphatase fell rapidly to normal and became elevated again with the recurrence of the tumor.

It has been noted by Kay[6] and Bodansky and Jaffe[7] that during the process of fracture repair there was an elevation of the serum phosphatase activity. Hunsberger and Ferguson[8] carried out serial determinations of serum phosphatase activity during repair of fractures in 18 clinical subjects and found that at varying intervals after fracture there was an increase in the serum phosphatase activity, with a slow return to normal as union progressed. They suggested that the extent of bone damage might account for the lack of uniform response in all cases.

According to various investigators the mechanism for the increase in serum phosphatase levels following fractures is not clear. Kay[9] has suggested that the enzyme is liberated from the damaged bone and soft tissues. He also suggests that the increased level may represent an overflow following increased activity locally at the fracture site. McKeown, Lindsay, Harvey and Howes[10] believe that the increase is due to mobilization of phosphatase from other depots such as the kidney, liver, *etc.*, in response to a substance elaborated by the fracture.

It was thought that a study of serial serum phosphatase determinations in a large series of fractures might determine:

1. If there was a consistent rise in serum phosphatase activity following fractures.

2. If the rise was not consistent, was there any correlation between the level of serum phosphatase and (*a*) the location of the fracture, and (*b*) the extent of the injury.

3. If the serum enzyme level could be used as an index of the rate of healing of the fracture and as a prognostic sign in the development of delayed or nonunion.

4. The mechanism for the increase in the serum phosphatase activity following fractures.

A series of 75 cases of fractures in adults has been studied. These cases were unselected with the exception that the majority of them were major fractures requiring hospitalization for a considerable period of time. Serial determinations of serum phosphorus and phosphatase were made the day following fracture and thereafter at weekly intervals for the following three weeks. In a few cases the studies were followed until union was complete. With the knowledge that diet, especially a high carbohydrate diet, could produce variation in the serum phosphatase level it was thought advisable to keep these patients on a standard diet. However, it was found to be very difficult to keep this number of patients on a weighed diet over the length of time necessary, and accordingly a uniform diet was planned and given to all fracture cases under study.

The Bodansky method of phosphatase determination has been used throughout in this series. According to Bodansky, the average normal adult serum phosphatase reading is 2.6 units with levels ranging from 1.5 to 4. In

serial determinations on normal individuals taken at weekly intervals, an average fluctuation of about one unit has been found. Accordingly, in computing whether there has been an increase or decrease in the serial determinations in this series, allowance has been made for this error.

The level of the serum phosphatase, of course, was not known prior to the fracture in any individual case. However, in about one-fourth of the cases, determinations have been made after complete healing of the fracture and the figures corresponded very closely with the readings taken the day following fracture. It is assumed therefore that the original reading probably represents the normal level of serum phosphatase for that individual.

A study of the serum phosphatase levels failed to reveal any consistent increase and, with very few exceptions, any significant change ·during the four weeks following fracture. In a few of the cases there was a striking increase in the serum phosphatase level but the majority showed only a very slight increase and many showed no change. At the end of one week 29 per cent of the readings were higher than the original levels, 16 per cent were lower and 55 per cent remained unchanged. At two weeks 43 per cent were found to be higher, 22 per cent lower and 35 per cent unchanged from the original levels. At three weeks 51 per cent were higher, 12 per cent lower and 37 per cent unchanged. However, on analyzing the individual cases, we find no consistent rise in the phosphatase level from week to week. Many of the cases showed a decreased value in the first and second weeks with perhaps a slight rise in the third week. Others showed a rise at the end of the first week with a subsequent drop to normal in the second and third weeks. Only 14 of the 75 cases showed a continued rise each week. With the exception of the cases of Paget's disease, the average phosphatase readings for the series were: on admission 3.74 units; seventh day 4.43 units; fourteenth day 4.69 units; and twenty-first day 4.77 units (Chart I).

An attempt was then made to correlate the serum phosphatase levels with the site of fracture. It had been suggested by Kay[6] that the cause of frequent

TABLE I

FRACTURES OF TIBIA (JUNCTION OF LOWER AND MIDDLE THIRD)

Serum Phosphorus and Phosphatase Determinations

	Admission		7th Day		14th Day		21st Day	
Case	Phos.	Phospha-tase	Phos.	Phospha-tase	Phos.	Phospha-tase	Phos.	Phospha-tase
17	2.20	4.87	3.77	2.34	2.68	4.25	3.20	6.60
25	3.50	4.92	4.20	9.13	3.88	7.16	3.92	5.64
27	2.70	4.78	3.48	5.32	3.68	5.44	3.70	5.98
29	3.50	4.34	3.62	7.02	3.20	7.31	3.48	4.70
30	2.06	5.39	3.05	4.29	3.66	4.56	2.88	6.22
31	4.58	5.00	4.30	8.02	4.10	6.30	3.84	5.48
37	4.39	6.96	4.83	4.28	3.82	3.17	4.16	4.36
40	3.28	3.32	3.47	3.15	3.16	2.86	3.98	4.78
Average	3.27	4.92	3.84	5.44	3.52	5.13	3.64	5.47

delayed or nonunion of fractures, occurring in certain locations such as the lower third of the tibia and the neck of the femur, might be due to the fact that these areas are low in phosphatase. If this were true, we might also expect lower serum phosphatase levels following fracture in these locations. In this series there were eight fractures at the junction of the lower and middle third of the tibia and ten intracapsular fractures of the femur (Tables I and II). However, as can be seen in Chart I, the phosphatase curves for these fractures closely approximated the curve for the total series.

TABLE II

INTRACAPSULAR FRACTURES OF THE FEMORAL NECK

Serum Phosphorus and Phosphatase Determinations

Case	Admission Phos.	Phosphatase	7th Day Phos.	Phosphatase	14th Day Phos.	Phosphatase	21st Day Phos.	Phosphatase
5	3.80	2.24	3.56	3.06	3.80	3.94	4.58	4.47
6	4.20	3.54	3.60	2.98	3.65	4.41	3.75	4.32
22	3.07	7.01	3.22	7.85	3.28	7.98	3.15	6.98
26	3.64	6.53	4.24	5.48	3.30	9.02	3.68	7.64
45	2.96	2.96	3.00	3.25	3.64	3.36	3.78	3.34
54	2.78	4.43	3.14	2.80	3.76	2.79	2.84	2.17
56	2.76	2.08	3.30	4.14	3.24	3.82	3.70	2.79
64	3.36	1.92	4.00	3.06	4.22	2.68	3.56	3.12
65	3.36	2.18	4.01	2.59	4.01	2.22	4.22	3.88
72	2.38	1.58	3.48	3.78	3.50	3.98	4.06	4.65
Average	3.23	3.45	3.55	3.90	3.64	4.42	3.73	4.33

TABLE III

FRACTURES WITH DELAYED AND NONUNION

Serum Phosphorus and Phosphatase Determinations

Case	Bone Involved	Admission Phos.	Phosphatase	7th Day Phos.	Phosphatase	14th Day Phos.	Phosphatase	21st Day Phos.	Phosphatase
4	Femur (Shaft)	2.90	3.48	2.90	6.56	3.46	7.09	3.44	3.94
16	Femur (Shaft)	4.14	2.64	4.14	2.15	3.68	3.45	3.78	5.28
21	Femur (Shaft)	3.26	2.17	4.22	9.33	4.07	3.67	3.85	3.80
25	Tibia	3.50	3.68	4.20	9.13	3.88	7.16	3.92	5.64
31	Tibia	4.58	5.00	4.30	8.02	4.10	6.30	4.22	6.79
50	Femur (Neck)	2.70	2.22	3.70	3.69	4.11	3.23	3.56	2.38
58	Femur (Neck)	3.38	1.76	3.78	2.29	3.54	3.36	4.06	3.80
Average		3.49	2.99	3.89	5.88	3.83	4.89	3.83	4.52

There were seven cases of delayed and nonunion (Table III). It can be seen by the accompanying diagram (Chart I) that, with the exception of an increase in the phosphatase activity at the end of the first week, there was no

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characteristic change in the levels to distinguish these cases from those that
went on to union in the normal time.

It would seem to follow that if the increase in serum phosphatase fol-
lowing fractures were due to either an overproduction of the enzyme at the
site of fracture or to a generalized response from other depots, then with
multiple fractures and those following severe trauma with comminution of
the fragments one would expect a marked increase in the serum enzyme level.
However, an analysis of five such cases shows no abnormal increase and in
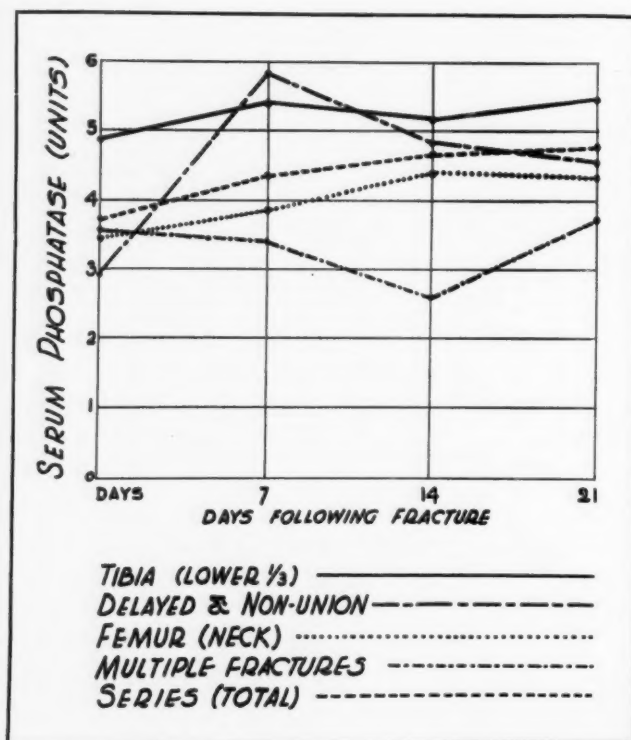fact in some instances there was found to be a decrease (Table IV).

CHART 1.—Showing composite amount of serum phosphatase recovered in
the various types of fracture considered.

Two cases of Paget's disease with fractures were studied. These were
both pathologic fractures of the humerus with very little displacement of the
fragments. The serum phosphatase readings are shown in Table V. Union
took place in the normal length of time without an abnormal amount of callus
formation. It would appear from a study of the first case (O.W.) that a
marked increase in the serum phosphatase activity had taken place following
fracture with a subsequent return to the original level in the third week.
However, the second case (J.B.) showed very little fluctuation.

It has been reported by Tisdall and Harris[11] that an increased blood
phosphorus reading was found consistently during the course of normal heal-

TABLE IV

MULTIPLE FRACTURES

Serum Phosphorus and Phosphatase Determinations

Case	Bones Involved	Admission Phos.	Admission Phosphatase	7th Day Phos.	7th Day Phosphatase	14th Day Phos.	14th Day Phosphatase	21st Day Phos.	21st Day Phosphatase
39	Humerus, Ribs, Olecranon, Pelvis	4.92	4.93	4.20	2.60	3.96	1.66	4.06	3.99
45	Tibia, Femur (Neck)	2.96	2.96	3.00	3.25	3.69	3.36	3.78	3.34
60	Femur, Pelvis	2.20	2.62	2.80	2.88	3.60	2.88	4.04	3.08
69	Pelvis, Clavicle	4.60	2.94	4.26	3.22	3.34	2.11	5.02	2.98
71	Pelvis, Clavicle	4.34	4.26	5.02	4.07	3.50	2.88	5.16	5.12
Average		3.80	3.54	3.85	3.40	3.62	2.57	4.41	3.70

ing of fractures. The absence of such a rise was presumptive evidence of a threatened nonunion. This was later refuted by Eddy and Heft,[12] Murray[13] and others, who found no consistent rise in the blood phosphorus following fractures. Hunsberger and Ferguson[8] reported an inverse ratio between the curves of serum phosphorus and phosphatase during the repair of fractures. A study of the present series appears to substantiate the findings of Murray

TABLE V

PAGET'S DISEASE WITH PATHOLOGIC FRACTURES

Serum Phosphorus and Phosphatase Determinations

Case	Bone Involved	Admission Phos.	Admission Phosphatase	7th Day Phos.	7th Day Phosphatase	14th Day Phos.	14th Day Phosphatase	21st Day Phos.	21st Day Phosphatase
O. W. 32	Humerus	3.41	27.60	3.12	37.00	3.92	34.20	3.46	24.70
J. B. 35	Humerus	3.26	19.10	3.82	15.84	4.28	22.72	3.76	18.74

in that very little fluctuation in the blood phosphorus level was noted. No decrease in blood phosphorus was noted in the cases of delayed and nonunion studied (Table III). Also, no evidence of an inverse ratio between the curves of phosphorus and phosphatase was found (Tables II, III, IV and V).

DISCUSSION.—It seems evident from the foregoing, therefore, that following many fractures there is a slight rise in the level of the serum phosphatase activity. This is not a consistent finding, however, and an attempt to analyze the various types of fractures has failed to account for the cause of this inconsistency. Undoubtedly phosphatase plays an important part in the process of fracture repair, as evinced by experimental work showing a marked

increase in its activity locally following fractures. It may be that in some cases there is a greater local phosphatase activity than in others, resulting in an overflow into the blood stream. It is doubtful that there is a generalized response from other organs high in phophatase, as in this case one would expect an earlier and more consistent rise of the serum level. It would appear that the increase in serum phosphatase following fractures is analagous to the increase seen in some cases of osteogenic sarcoma. In the latter instance the increased serum phosphatase activity is presumably dependent upon activity of the bone tumor. Similarly, it may be assumed that the increase in phosphatase activity at the fracture site as demonstrated by Regen and Wilkins, Botterell and King, results in a secondary increase in the serum level.

No conclusion can be drawn from the two cases of Paget's disease studied, with the exception perhaps that a high level of serum phosphatase activity does not accelerate the rate of healing of fractures. In the literature reviewed, no observers have reported accelerated healing of fractures in cases of Paget's disease or osteitis fibrosa cystica.

CONCLUSIONS

(1) There is not a consistent rise in the serum phosphatase level in the course of fracture healing although in many cases there is a slight increase, while in a smaller group there is a decrease.

(2) The increased serum phosphatase activity following fractures appears to be secondary to the increased activity at the fracture site and not vice versa.

(3) The serum phosphatase level following fracture is not an index of the healing or rate of healing of the fracture.

(4) No significant change in the blood phosphorus level following fracture was noted.

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BRIEF COMMUNICATIONS
AND CASE REPORTS

RECURRENT DUODENAL ULCER FOLLOWING PREVIOUS PERFORATION *

PARTIAL GASTRECTOMY

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CASE REPORT

A MALE, aged 42, was admitted to Beekman Street Hospital October 27, 1933, shortly after a sudden collapse resulting from an attack of severe upper abdominal pain. For three days he had been suffering from epigastric discomfort which had grown progressively more severe, culminating in the above episode. In 1929, after a 15 year history of recurrent postprandial pain, he had a perforation of a duodenal ulcer which was sutured at Kings County Hospital. He remained well for about one year, following which there was a recurrence of digestive complaints which persisted until the time of admission.

Examination suggested either a walled-off perforation or a subacute perforating duodenal ulcer. The acute signs subsided after 48 hours, but the digestive discomfort persisted despite medication and Sippy diet. Roentgenograms revealed a constant defect on the lesser curvature of a deformed bulb suggesting a penetration from it. Because of the history and the uncontrollable symptoms, the patient was explored November 11, 1933. The under surface of the liver was found to be intimately adherent to the first portion of the duodenum, which, when separated, revealed an open penetration extending into the gastrohepatic ligament, arising from the anterior aspect of an adherent duodenal ulcer of the posterior wall. A partial gastrectomy, including the ulcer, was performed, employing the Hoffmeister modification to effect a posterior no-loop suture gastrojejunostomy.

After an uneventful postoperative course, the patient was discharged on the seventeenth day. Except for mild epigastric discomfort, particularly after large meals, during the first six months, he has remained well and free from digestive symptoms.

The impression that most cases of acute perforated duodenal or pyloric ulcer tend to remain well is controverted by careful follow up observations which reveal a 40 to 50 per cent recurrence of symptoms in such cases. The explanation for this is revealed in resected material obtained by partial gastrectomy. A survey of 25 such cases, 22 from Mt. Sinai Hospital and three from Beekman Street Hospital, showed the presence, in every instance, of either a separate duodenal ulcer of the posterior wall or an encircling ulcer of the posterior wall, tending to perforate at its most anterior aspect, as exemplified in the case presented. These lesions, unquestionably present at the time of the acute perforation, persist and are responsible for recurrent symptoms. It is obvious why anatomically anterior ulcers are the ones to

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perforate into the free peritoneal cavity, and posterior ulcers tend to be walled off by either the pancreatic capsule or the liver. Apparently it is the solitary ulcer of the anterior wall which tends to remain well after an acute perforation.

The practical significance of these observations may be applied to the management of these lesions. The simple suture is favored for an acute perforation as the safest procedure in an immediate, grave surgical condition. When uncontrollable recurrent symptoms manifest themselves, surgery is indicated, partial gastrectomy being favored, whenever feasible, as the procedure most likely to give the best result.

DISCUSSION.—DR. RICHARD LEWISOHN (New York) stated that these ulcers should be called persistent rather than recurrent ulcers. At Mt. Sinai Hospital 39 per cent of the patients had persistent symptoms after an acute perforation of a duodenal ulcer, due either to the fact that an ulcer of the anterior wall persists in spite of the suture or that, in addition to the anterior ulcer which perforated acutely and was sewed over, an ulcer of the posterior wall existed which, of course, was not affected by the surgical procedure. The procedure now favored at Mt. Sinai Hospital is simple suture of the ulcer without a gastro-enterostomy, on account of the dangers of a subsequent gastrojejunal ulceration. Enderlen has reported 51 per cent of gastrojejunal ulcers following gastro-enterostomy in connection with an acute perforation. Of course, large punched out ulcers may be encountered where a safe suture is practically impossible. If this type of lesion comes to the operating table early, that is within six hours after the perforation, the surgeon should weigh the evidence, whether it is not safer for the patient to have a primary partial gastrectomy performed rather than an unsafe suture of the perforation with the possibility of a postoperative leak.

DR. HENRY F. GRAHAM (Brooklyn) called attention to an article by Doctor Platou some years ago which contained an analysis of 70 cases of operation for perforation of duodenal ulcer with end-results. He found that when simple suture was performed, one-third came to later operation, one-third had persistence of symptoms, and one-third were cured. In one case of a large blow-out ulcer nothing was done other than to pack the perforation with gauze. A complete recovery without recurrence of symptoms ensued. The cases of suture plus gastro-enterostomy were all free from symptoms of disease. Doctor Graham stated that he had had two or three patients in whom a simple suture for perforation was followed by death. Nevertheless, after several years' experience with it, he felt it to be the method of preference. At the Methodist Hospital the rule is that if the patient's general condition is good and he is seen early enough after the acute perforation of a duodenal ulcer, gastro-enterostomy is performed; otherwise, simple suture.

DR. FRANK E. BERRY (New York) said that in early cases where there is an extremely large perforation presenting a difficult problem for simple repair, primary resection must be seriously considered. Such a case reported before the New York Surgical Society some years ago is still well although eight years have elapsed since perforation.

DR. JOHN A. McCREERY (New York) added that the case of acute perforation in which a resection was done by Doctor Berry represented the

only one in 150 acute perforations on his service in which this operation had been possible. In a few others it would have been advisable, but they were late cases in which the patient's condition made such a procedure unwise. In the average case, the proper procedure was simple closure of the perforation. Ten years ago it was Doctor McCreery's belief that he could tell, at the time of perforation, whether any additional procedure, such as gastroenterostomy, would be necessary. At present, however, it is his conviction that the course of ulcer following perforation cannot be determined, and, therefore, closure alone is indicated. He could not entirely agree that patients returning for further treatment have persistent rather than recurrent ulcers. He has had patients who had been free from symptoms for as long as 11 years following perforation, only to return with definite ulcer symptoms, often requiring operation. The period of freedom from symptoms in these cases was so long that it seems more probable that the second ulcer was a new rather than a persistent one, even though occurring at the same site as the original lesion. The procedure in secondary operations should be governed by the same principles that decide the procedure at the primary operation. In many of his secondary operations for obstruction, he has been satisfied with a posterior gastro-enterostomy.

STRANGULATED UMBILICAL HERNIA AND CONCOMITANT GANGRENOUS APPENDICITIS *

Condict W. Cutler, Jr., M.D.

New York, N. Y.

Case Report.—A female, aged 29 entered Roosevelt Hospital May 22, 1935, complaining of having had abdominal pain for four days, accompanied by vomiting and complete obstipation for two days. Since the birth of a child five years before, she had had a swelling in the region of the navel. This mass, always present, was larger at certain times. Occasionally, after exertion, it became quite hard, swollen and painful, with occasional associated abdominal cramps.

Four days before admission, after lifting a heavy weight, the mass became larger and painful, and was accompanied by general abdominal pain of cramplike character. She felt sick and feverish and a laxative did not relieve her. For the two days immediately before admission, there was continual severe general abdominal pain, frequent emesis, and inability to pass flatus.

On examination she appeared prostrated and dehydrated. The abdomen was distended, tympanitic, somewhat rigid and generally tender. At the umbilicus, and extending toward the right, was a protruding mass. There was some superficial redness over the mass, which was firm, not tympanitic and tender. The patient said it was twice its usual size. There was also marked tenderness in the right lower quadrant. Temperature, 101.2° F. Leukocytes, 21,000; polymorphonuclears, 92 per cent. The high leukocytosis, in conjunction with the relatively low temperature and the local tenderness in the right lower quadrant, led to the suspicion of acute appendicitis. Yet the evidence of strangulated, or at least incarcerated, umbilical hernia, with obstructive symptoms, could not be ignored.

Operation.—After an infusion, a right rectus incision was made. Through this the hernial sac was first investigated. Its wall was markedly thickened and edematous, and it contained a mass of inflamed, adherent and strangulated omentum, but no intestine. The omental mass was resected, and its stump reduced. Exploration of the right

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lower quadrant was now done. Here a partially walled off abscess which surrounded an appendix was encountered, lying in the flare of the ileum, covered with fibrin and pus, gangrenous in its distal third and perforated near the tip. This was removed and a stab wound was made in the right inguinal region for drainage. With little hope of success, in a field already contaminated, an improvised repair of the hernial orifice was effected, the sac having been removed. This wound was also drained.

The patient's recovery was complicated by a bronchopneumonia. The temperature reached normal on the thirteenth day. The rectus wound did not break down, but a sinus tract persisted in the drained area near the umbilicus. The stab wound closed and she was discharged on the twenty-first postoperative day. Two months later she was readmitted for the drainage of a large mural abscess which had developed in the right abdominal wall. Her recovery was uneventful and the hernia has not recurred as yet.

The case is shown as illustrating the confusing concomitance of two acute surgical conditions within the abdomen.

DISCUSSION.—DR. ELLSWORTH ELIOT, JR. (New York) said that associated conditions of the abdomen—they might better be called coexisting—could be divided into two groups: the first consisting of those in which the two lesions are rather intimately related to one another, and the other consisting of those in which two or more lesions are entirely independent of one another. If the gangrenous appendix had been within the hernial sac, it would have been a coexisting lesion intimately associated with the hernia. However, it was entirely separate from the sac and hence the lesions would belong to the group of independent coexisting conditions. An interesting instance belonging to the group in which the lesions were interdependent was one reported by Dr. E. R. Easton, occurring at the Knickerbocker Hospital, of a gangrenous appendix within the hernial sac, in an adult male who, after sudden exertion, experienced a pain in the region of the umbilicus, followed shortly by the appearance of a hernia in the right inguinal region which became irreducible. A diagnosis of an acute appendix in addition to the hernia was made, being influenced chiefly by the fact that the abdominal symptoms were referred to McBurney's point above and to the outer side of the internal abdominal ring. It is important in cases of coexisting lesions to determine and weigh the difference in the physical signs other than those of hernia alone. Had strangulated hernia been the only lesion, certainly before peritonitis developed the symptoms would have been localized to the immediate vicinity of the swelling. Here, however, the symptoms were not only those of acute irreducible hernia, but they were referred to a distant, though not remote, part of the abdomen.

Two other cases are especially interesting. The first involved an acute irreducible hernia in a man of 56, occurring in the left inguinal region. The advent of irreducibility—the hernia having been reducible for a good many years—was preceded for a short interval by abdominal pain, referred to the umbilicus. Only after two or three hours, during which the patient sought relief by removing his truss, was the pain referred to the left inguinal region and then to the scrotum. On examination, there was noted not only an acute irreducible hernia but the patient had marked tenderness and rigidity above the region of the umbilicus on both the right and left sides. A diagnosis of some intra-abdominal condition other than that of hernia was considered. Dr. P. D. Allen, who operated upon the patient, left the irreducible hernia intact and opened the abdomen through a rectus incision above the level of the umbilicus, which disclosed a perforation of the stomach on its

anterior surface near the pylorus on the lesser curvature. This was sutured. The patient's hips were then elevated and the acute irreducible hernia, incarcerated but not strangulated, was reduced. The patient died after eight days from delirium tremens.

The second case, even more striking, involved a strangulated ventral hernia in the scar of a former abdominal incision for the relief of a gastric perforation five years previously. Here, again, in addition to symptoms of strangulation, were those of acute peritoneal irritation with resistance on both sides in the costal arch and both flanks. It was different, however, from the other case of hernia for the omental contents were distinctly strangulated with bloody fluid in the sac. After the relief of the strangulation, incision prolonged into the abdomen exposed a crater-like perforation of the anterior part of the stomach near the pylorus. This was closed, the hernial orifice repaired, and the patient made a very good recovery.

In both cases, the diagnosis was aided by a previous gastric history. The case of incarcerated inguinal hernia gave a history of dyspepsia, fulness of the stomach and other signs of digestive disturbance for four or five years, relieved only by the taking of bicarbonate of soda and magnesium. In the second case, the diagnosis of some intra-abdominal lesion was facilitated by the fact that the patient had had a previous perforation and that these perforations are known to occasionally recur. The presence of abdominal symptoms in addition to those of an incarcerated or strangulated hernia certainly justified thorough exploration of the abdominal cavity.

POSTOPERATIVE INFECTIONS

Paul W. Harrison, M.D.

Muscat, Arabia

Meleney[1] states that 15 per cent of apparently clean operations become infected. Eliason and MacLaughlin[2] from a survey of the literature estimate the average as 10 per cent. With our present knowledge and resources, the infection of clean surgical wounds should be much less. Evidently there is some factor of importance which is b ing overlooked. Bandy has shown that the sterilization of surgical dressings is not always thoroughly accomplished. The importance of careful masking of the nose and mouth is well known. Our experience in Arabia has demonstrated another factor which has proven of definite value, and attention to this point in technic has caused a great improvement in the incidence of wound contamination.

It is a mistake to think of any of our operative wounds as "sterile," *i.e.*, as completely uncontaminated by micro-organisms. The work on "Liver Autolysis in the Peritoneum," recently reported by Trusler,[3] is an interesting demonstration of how far from completely aseptic most surgical wounds are. In all of them the resistance of the tissues is pitted against a certain amount of contamination, and if the contamination exceeds this degree of resistance, infection results.

Subcutaneous injections are often carelessly prepared and imperfectly sterilized, but they almost never cause infection. Evidently the tissue must

have a highly developed capacity to resist infection. But in the presence of a foreign body and trauma this capacity is greatly reduced. This was demonstrated by von Behring and Kitasato in the early investigations which led to the discovery of tetanus antitoxin. In all of our surgical wounds, the necessary placement of ligatures and buried sutures introduces foreign bodies throughout the whole traumatized area. Moreover, these foreign bodies are not only inserted as mere inert masses, whose presence constitutes a handicap to the tissues they touch, but in the knot is enclosed a mass of tissue which is killed by the pressure to which it has been subjected, and this constitutes an ideal culture media for any contaminating organism.

To these facts is to be added another, whose significance we were slow to appreciate, namely, that the infections which developed in our clean cases were apparently always associated with ligatures and buried sutures. We closed our wounds with silk, so it was impossible to blame the infection on poorly sterilized catgut. Masking was carefully observed, and the period of sterilization for dressings was doubled. It was soon apparent that we were faced with a factor which we did not appreciate. Primarily the skin of our patients is incredibly dirty, especially in the region of the groin. Our protection against dust is very poor, and on the tours, where much of our work is done, we have very little protection against the flies.

It was evident that in this situation our best technic was producing wounds contaminated slightly enough to be easily handled by normal tissues, but not always of a degree enough to be successfully handled when the contamination affected the ligatures. Our ligatures were first put in a condition of absolute bacteriologic sterility. Needles and thread are boiled for ten minutes or more. The needles are threaded with forceps, are absolutely untouched and are kept between sterile towels until the time when they are actually used. They are carefully kept from all contact with the edges of the wound, and the knots are tied with forceps. On those occasions when it seems imperative to tie a large vessel by hand, the fingers grasp the thread, at a distance from the knot sufficient to ensure that no portion of the touched thread remains in the wound.

We have had a striking opportunity to test the correctness of these ideas. Arriving in a new city, on one of our tours, we were nearly pulled from our camel by the anxious brother of a man with a strangulated hernia. Instruments were hurriedly placed in one large enamel dish, and in another towels, together with sponges cut en masse from a bolt of gauze, and left unfolded. These were boiled over two powerful Primus stoves for ten minutes. Mats on the floor served as an operating table while a sterile towel spread on the floor served as the instrument table. The patient may have gas pains afterwards, but it is the doctor who has the backache. There were an appalling number of flies present. A hemostat laid on the sterile towel did not show a square millimeter of metallic surface. It was outlined solidly in flies. A sponge showed every spot of blood covered in the same way. The opera-

tive wound was contaminated by hundreds of flies who flew into, and walked through it.

The only things kept clean were our needles and silk. They were carefully placed between folds of sterile towels till needed, and were apparently uncontaminated. The contamination of the wound had been so obvious that a few strands of silkworm gut were placed in its lower angle as a drain. The wound healed perfectly without the slightest trace of infection.

This experience gave us confidence in the correctness of the ideas formulated, and now the most rigorous care is devoted to keeping our ligatures and suture material absolutely uncontaminated. Our results have improved very markedly, and wound infections are of rare occurrence even on tours. On a recent trip we operated upon eleven herniae, one hydrocele, five goiters, performed three hysterectomies, one exploratory laparotomy and one amputation of the thigh. In none of these, nor in several miscellaneous clean minor operations, was there the slightest suggestion of any postoperative infection.

Compared to the results we previously obtained, and taking into consideration the handicaps of primitive conditions, it seems to us that a considerable advance has been made, and we feel it is entirely due to the instrumental technic employed.

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GAS GANGRENE OF WOUND OF WRIST *

ANTITOXIN TREATMENT

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New York, N. Y.

Case Report.—T. P., aged 30, admitted to St. Luke's Hospital on November 3, 1934. Twenty minutes before admission he had forced his hand through a plate glass window, lacerating the right wrist, and severing the following structures: ulnar nerve, including its dorsal branch, ulnar artery, flexor carpi ulnaris, flexor digitorum sublimis and flexor digitorum profundus to both the fourth and fifth fingers. There was, also, a moderate amount of maceration of the muscular structure in the immediate vicinity of the injury.

Fifteen hundred units of tetanus antitoxin were administered, and under general anesthesia, within an hour of the accident, the dead tissue was cut away, the structures were identified, and a nerve suture performed, together with a suture of all tendons. The wound was closed with black silk and a small rubber drain was placed in the center. The wrist and fingers were placed in flexion and a molded dorsal splint was applied.

* Presented before the New York Surgical Society, October 23, 1935.

The operation was performed late in the evening. The next day there was nothing unusual about the patient's appearance or his temperature. Twenty-four hours after operation he complained of pain, and at the end of 36 hours, when his wound was dressed, there was a lymphangitis to his elbow, edema and swelling of the forearm, and a temperature of 104° F. The wound was opened and extended. At the site of all the tendon sutures, the structures were discolored but not completely gangrenous, and gas could be expressed and even seen bubbling from the wound. The wound itself was thoroughly cleansed and multiple incisions were made in the forearm and upper arm. Four hours later (40 hours postoperative) he was given 80 cc. of Lederle's Polyvalent Gas Gangrene Antitoxin intravenously. The introduction of this material was followed by some bronchial spasm. This was relieved by adrenalin. Four hours later, another 80 cc. was administered with adrenalin. His temperature fell from 104° to 103° F. and the general appearance of the wound had definitely improved by evening. Twenty hours later a third administration of 80 cc. was given intravenously, and from then on the temperature subsided and the wound improved markedly in appearance. Smears and culture taken at the time the wound was reopened showed C. welchii.

Wet dressings of hydrogen peroxide were applied continuously for four days, and then Dakin's dressings. Twenty days postoperatively, the wound culture was negative for gas bacillus, and again on the twenty-second day. There developed a very severe angioneurotic edema 10 days postoperatively, which was temporarily controlled by adrenalin. The wound was allowed to granulate and a Thiersch skin graft was performed on the twenty-fourth day postoperatively, with the hope of preventing extensive adhesions.

After discharge from the hospital, the hand showed definite evidence of ulnar nerve section. The ability to flex the wrist was not lost, but the flexion of the fourth and fifth fingers was definitely impaired. Within three months the sensory changes began to improve in the fingers. The lack of ability to flex the fourth and fifth fingers was, however, so distressing to the patient that he was readmitted to the hospital on June 21, 1935, and a secondary operation was performed. It was found that the flexor digitorum sublimis and profundus to these two fingers were adherent to the scar, but had not become entirely separated at the point of suture. However, they were very much stretched out. The ulnar nerve was not dissected out, but with a return of sensation and improvement in atrophy of the muscles it was felt that its continuity had not been interrupted by the infection. The flexor carpi ulnaris was intact. The flexor digitorum sublimis and profundus were dissected free and were shortened by plication. The wound was closed with drainage, and a dorsal splint applied with the fingers and wrist in flexion. Healing was by primary union after the drain was removed.

The patient now has excellent flexion of the fingers but the scar is adherent to the underlying structures and a full thickness graft or a pedicle graft will later be placed over this area.

This case has been shown for the following reasons:

(1) The advantages of prompt intravenous therapy in the case of gas gangrene which, in our opinion, prevented extensive sloughing of the sutured tendons.

(2) The importance of having adrenalin immediately available when intravenous serum therapy is administered.

DISCUSSION.—DR. HOWARD LILIENTHAL (New York) said that Doctor Morton's case was almost a duplicate of one he had presented before the Academy of Medicine in 1892.[1] A boy had cut, with a piece of glass, all the tendons of his right wrist, the median nerve and radial artery, down to the bone. One hour after the accident multiple tenorrhaphy was performed.

The wound was infected. The sutures were removed and wet dressings applied. The boy recovered but with all fingers stiff. At a subsequent operation the tendons were not cut but instead the scar was divided into strips, each strip was left attached to its severed tendon. Physiotherapy and electrotherapy were employed very early. The final condition is a useful hand with motion in all fingers.

REFERENCE

[1] New York Medical Journal, **56**, 516–518, 1892.

CORRECTION

June, 1936, issue, page 871, line 5, the word "anaerobic" should read "aerobic."